Climate Risk: Insurance Firms, Corporate Bonds and the Long Run Exposure

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Abstract

We examine how long-run underwriting exposure to property losses affects P&C insurers' investment in corporate bond sub-portfolios. By endogenizing the exposure to climate risk for P&C insurers, I argue that while imposing additional constraints on the portfolio can adversely affect expected risk-adjusted returns in the short run, P&C insurers exposed to property losses have started moving capital away and charging higher yields from firms belonging to emission-intensive industries to reduce long-run underwriting risk exposure to extreme weather events. I also show that these insurers have begun investing more in Green bonds to facilitate climate action projects and reduce GHG emissions in the long run. These findings suggest that the concern about Impact materiality is endogenous and may stem from the Financial materiality of climate risk.

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1. Introduction

Understanding how long-term exposure to extreme weather events shapes the behavior of Property and Casualty (P&C) insurers has become increasingly important as the world faces accelerating climate risks. P&C insurers play a critical social welfare function by mitigating the financial consequences of extreme weather for households and businesses. Most US P&C insurers have operated for decades, implying that long-term survival—beyond short-term solvency—fundamentally influences their strategic decisions. Rising uncertainty surrounding the severity and frequency of extreme weather events threatens significant challenges for these firms, undermining their ability to accurately price and hedge climate risks. As noted in the Allstate Corporation's 10-K filing[1], "Due to significant variability associated with future changing climate conditions, we are unable to predict the impact climate change will have on our businesses." This uncertainty reinforces the notion that timely reductions in greenhouse gas (GHG) emissions and a broader green transition align with the long-run interests of the insurance sector.

Although P&C insurers themselves emit relatively little GHGs, they can influence the broader risk environment. To mitigate long-term exposure to extreme weather events, insurers may either remain passive, waiting for government action and international agreements to curb emissions, or take a more proactive stance by influencing emissions outcomes through underwriting and investment decisions. On the underwriting side, P&C insurers can design policies that discourage high-emitting activities or encourage mitigation efforts. On the investment side, P&C insurers can adopt investment strategies that support green transition and thus help curb future climate risks.

Greenhouse gases (GHGs) remain in the atmosphere for long periods, and past GHG emissions affect the future temperature increase (IPCC, 2021)[2] Also, each increment in global warming substantially increases the severity and intensity of extreme weather events (IPCC, 2021). Reducing emissions today can slow the pace of global warming and reduce uncertainty about future extreme weather events. Such uncertainties are particularly detrimental for P&C insurers, especially those covering property losses, because they complicate premium pricing, loss-reserve estimation, and reinsurance planning.

In this study, we examine the investment behavior of P&C insurers in response to long-run underwriting exposure to climate risk. We mainly study how P&C insurers, as institutional investors, allocate capital in corporate bond markets to facilitate reductions in GHG emissions by the firms they finance.

[1] See https://www.allstatecorporation.com/resources/allstate/attachments/annual-report/allstate-year-end-report-combo-2024.pdf (Accessed on July 25^{th}, 2025)

[2] As per IPCC (2021), each 1000 $GtCO_2$ of CO_2 emissions increases global surface temperature by approximately 0.45°C.

When examining investment decisions based on firms' emission profiles or ESG factors, the literature has primarily focused on two explanations: investors' non-pecuniary, value-driven preferences (Dangl et al., 2025; Starks, 2023) and the financial materiality of firms' climate risk exposure (Pástor et al., 2021, 2022; Bolton and Kacperczyk, 2021b; Ilhan et al., 2021; Ehlers et al., 2022). Starks (2023) categorized these two investment approaches as 'Values' and 'Value', respectively. We argue, however, that these two approaches are rather simplistic, as they are agnostic to investors' own intertemporal climate risk exposure (especially extreme weather events). The omission is especially consequential for P&C insurers, whose underwriting portfolios are directly vulnerable to climate-related property losses. For P&C insurers, long-horizon underwriting risk is of grave concern due to the uncertainty about the severity and impact of extreme weather events. The long-run, uncertain nature of these risks makes them difficult to hedge effectively (Alekseev et al., 2022). If insurers continue to invest in emission-intensive firms in a business-as-usual manner, they may inadvertently increase their own long-run underwriting risk by contributing to a higher probability of extreme weather events. As a result, insurers exposed to property losses might face a larger number of highly correlated claims. Taken together, these considerations suggest that climate change should be viewed as endogenous to the business operations of P&C insurers, rather than solely as an external factor influencing investment or underwriting decisions.

If climate risk exposure is endogenous to P&C insurers' operations, a natural question arises: whether they invest in ways that mitigate their long-run underwriting risk, and, if so, which investment strategies they adopt? The climate finance and asset pricing literature has primarily focused on three investment strategies — divestment from emission-intensive firms, engagement with such firms, and demanding higher expected returns from them to compensate for climate-related risks (Bolton and Kacperczyk, 2021a,b). However, the theoretical motivations for these strategies mainly come from the 'Values' and 'Value' perspective (Starks, 2023). In this research, we investigate whether the motivations for adopting these investments can be driven by insurers' own exposure to long-term underwriting risk. In particular, we primarily focus on insurers' divestment and return-based investment strategies regarding firms with high emissions.

To study how P&C insurers adjust their investment behavior in response to long-run underwriting risk, we divided the insurers into two groups based on their exposure to property losses. Following Jung et al. (2023), insurers underwriting Homeowners or Commercial Multiple Peril (MP) are categorized as "Exposed P&C insurers" while the remaining insurers are categorized as "Other P&C insurers". We argue that if Exposed P&C insurers reduce their holdings of corporate bonds issued by Brown (i.e., emission-intensive) firms, it would indicate that these firms consider factors beyond non-pecuniary preferences or transition-risk exposure when making investment decisions.

Moreover, as climate risk exposure is endogenous to the underwriting business of P&C insurers, a reduction of investment in Brown firms or a demand for higher returns from such firms can be interpreted as a mechanism through which Exposed P&C insurers incentivize Brown firms to reduce GHG emissions. Absent this endogenous risk channel, there is little plausible explanation for why reductions in investment in Brown firms would occur predominantly among Exposed P&C insurers.

The key findings are as follows: First, P&C insurers reduce their investment in corporate bonds issued by Brown firms as their exposure to property-loss risk increases. To construct insurer-specific risk exposure, we aggregate the logarithm of property damages reported in the SHELDUS dataset across states and weight each state's damages by the insurer's business share in Homeowner and Commercial MP business lines within that state. This result suggests that Exposed P&C insurers consider climate risk as endogenous to their operations. By reducing their holdings in Brown firms, Exposed P&C insurers seek to signal to Brown firms that these firms should accelerate their decarbonization efforts. The finding indicates that insurers' idiosyncratic exposure to climate risk is an important determinant of investment behavior that cannot be fully explained by the 'Values' or 'Value' considerations alone.

Second, we find that P&C insurers exposed to property losses demand higher returns on the corporate bond issued by Brown firms. The findings indicate that there are factors beyond exposure to transition risk, traditionally emphasized in the literature[3], also influence return expectations for brown assets. This evidence suggests that Exposed P&C insurers are incorporating their long-run underwriting exposure to climate risk into the pricing of corporate bond portfolios by requiring higher yields from Brown firms. Had this been driven solely by transition risk considerations, we would expect Other P&C insurers to also demand higher returns from Brown firms, which reinforces the interpretation that idiosyncratic underwriting exposure plays a central role.

Third, we find that post Paris Agreement (COP21), Exposed P&C insurers increased their investments in Green bonds relative to Other insurers. As Green bonds are specifically issued to fund projects that reduce GHG emissions, this shift towards Green bonds shows that long-run climate risk exposure is a salient concern for Exposed insurers. Overall, the results demonstrate that institutional investors are not a homogeneous group; their long-term exposure to climate risk significantly influences their investment behavior. Consequently, when investors allocate their investments differently across emission-intensive firms, we cannot attribute such patterns solely to non-pecuniary preferences or exposure to transition risks. A deeper examination is required to determine whether climate risk impacts their underlying business operations and whether

[3]See Bolton and Kacperczyk (2021a,c,b); Pástor et al. (2022)

their cash flows depend on those exposures.

This study contributes to the ongoing research on the determinants of investment in financial assets based on firms' emission profile and ESG characteristics (Starks, 2023; Aswani et al., 2024; Bolton and Kacperczyk, 2021c,b; Dangl et al., 2025; Pedersen et al., 2021). While prior work has emphasized 'Values' and 'Value' based considerations, this study demonstrates that idiosyncratic exposure of P&C insurers to property losses on the underwriting side is an important driver of their investment decisions related to emission profile. Exposed P&C insurers appear to adjust their portfolios in ways that mitigate the long-run impact of physical climate risk (Financial Materiality) on their underwriting business.

This study also contributes to the literature on investment behavior of insurers (Ellul et al., 2011, 2022; Ge and Weisbach, 2021; Chen et al., 2020; Knox and Sørensen, 2023; Becker et al., 2022; Chaderina et al., 2022; Becker and Ivashina, 2015). The existing literature primarily adopts a unidirectional perspective, focusing on how factors related to underwriting business influence investment decisions. One strand of literature argues that insurers facing financial constraints on the underwriting side tend to take higher investment risk (Ellul et al., 2022)[4]. Another strand argues that when insurers face more financial constraints on the underwriting side, they shift their investment toward safer assets (Chen et al., 2020; Ge and Weisbach, 2021). Only a limited number of studies have examined the bidirectional relationship between underwriting activities and insurers' investment choices (Knox and Sørensen, 2023). In this study, we examine this bidirectional relationship in the context of climate risk exposure. focusing on how long-run physical climate risk influences the corporate bond portfolio of P&C insurers.

The remaining part of the paper is structured as follows. Section 2 discusses the paper's related literature, conceptual background, and main hypotheses. Section 3 discusses databases used, variables adopted, and descriptive statistics. Section 4 discusses the empirical strategy and results of all the main hypotheses. Section 5 discusses the trends in the acquisition of corporate bonds based on the exposure to property losses. Section 6 discusses the investment in Green bonds, especially after the Paris Agreement. Section 7 discusses the robustness of findings. In section 8, we discuss the findings of this study and conclude the study.

2. Conceptual Background

The sustainable finance literature has broadly identified two approaches to climate-related investment: the 'Value' and 'Values' perspectives (Starks, 2023). The 'Value'

[4]Ellul et al. (2022) show that life insurers with higher underwriting exposure in variable annuity products with guaranteed income tend to invest more in riskier and illiquid bonds to earn higher yield.

approach emphasizes the financial materiality of the impact of climate change (both physical[5] and transition risk[6]) on financial assets. Under this framework, investors incorporate the effects of climate risk exposure on the risk-return characteristics of financial assets (Pedersen et al., 2021). Apart from traditional risk factors identified in the asset pricing literature, the 'Value' approach considers climate risk as an additional material risk factor influencing asset pricing and expected returns (Pástor et al., 2021, 2022). This strand of literature generally considers investors as representative agents.

By contrast, the 'Values' preference emphasizes investors' non-pecuniary social preferences, moral beliefs, and psychological satisfaction of doing good ("Warm glow") derived from supporting certain firms and activities. From this perspective, investors may avoid firms whose operations generate negative externalities, such as contributing to extreme weather events, and therefore choose not to invest in such firms (Hong and Kacperczyk, 2009) or demand higher expected returns from them (Chava, 2014). Investors motivated by 'Values' considerations are usually called socially responsible investors, whose behavior may reflect deontological, non-consequentialist, or consequentialist motivations (Dangl et al., 2025).

Deontological investors avoid securities issued by emission-intensive firms based on principles of moral responsibility (Hong and Kacperczyk, 2009). Non-consequentialist investors derive utility from investing in firms that align with their value system, moral beliefs, and ethical beliefs (Bonnefon et al., 2025; Heeb et al., 2023; Chava, 2014). For these investors, the personal satisfaction of doing good matters more than the actual impact on GHG emissions. In contrast, consequentialist investors (also labelled as *Impact* investors) focus on the materiality of their impact. They aim to reduce negative externalities on society through targeted investment strategies (Dangl et al., 2025; Gupta et al., 2022; Heeb et al., 2023). Investors with 'Values' preferences may be willing to forego a part of their financial return to experience the psychological satisfaction of doing good, to support decarbonization efforts, or both (Starks, 2023; Heeb et al., 2023; Riedl and Smeets, 2017).

However, we argue that the 'Value' and 'Values' framework offers an overly simplistic approach to explain investment behavior in climate finance, as it remains agnostic to heterogeneity in investors' own climate risk exposure. For P&C insurers in particular, climate risk is endogenous to their underwriting operations. By allocating capital

[5]Physical risk refers to the exposure of financial assets to climate-related events. There are mainly two types of physical risk (Acharya et al., 2022)–Acute Physical Risk, arising from sudden events such as floods, wildfires and hurricanes; and Chronic Physical Risk, stemming from slow-moving phenomena such as rising sea-level, long-run temperature changes (Pástor et al., 2024).

[6]Transition risk refers to the vulnerability of emission-intensive firms to climate policies, shifts in consumer and investor preferences, and technological changes associated with green transition(Pástor et al., 2024).

to emission-intensive firms that continue to emit GHGs, insurers may inadvertently increase their long-run underwriting risk by increasing the probability of extreme weather events. Because the severity and frequency of such events are highly uncertain (Barnett et al., 2020; Barnett, 2023), P&C insurers may find it challenging to manage the underwriting risk and maintain solvency. Moreover, given the long-run impact of climate risk, designing effective financial instruments to hedge these exposures is difficult (Engle et al., 2020).

In response, P&C insurers have started withdrawing from certain high-risk geographies and increasing premiums on policies, particularly Homeowners and Commercial Multiple Peril lines, that cover property losses. The issuance of catastrophe Bonds (Insurance-linked Bonds) has also doubled during the last decade[7]. Yet these strategies primarily help insurers cope with losses post-disaster and do not reduce the ex-ante risk of extreme weather events by reducing GHG emissions. Furthermore, large-scale market withdrawals from certain markets and an escalation in premiums are not prudent options from a social welfare perspective. Against this backdrop, the central question We examine is whether P&C insurers adjust their investment portfolios to reduce their long-run underwriting risk from extreme weather events.

Ex-ante, it is unclear whether P&C insurers adopt any investment strategy to address rising GHG emissions, and, if so, what form these strategies take. The literature identifies two potential strategies: divestment (exit) and engagement (voice) (Broccardo et al., 2022). Divestment means refraining from investing in the equities and bonds of emission-intensive firms and may require investors to forego some return or diversification benefits. Engagement entails exercising voting rights and influence through equity ownership, as expressed through shareholder proposals and proxy voting (Broccardo et al., 2022; Krueger et al., 2020; Dyck et al., 2019; Kahn et al., 2023). Between these two approaches lies a tilt strategy (Pástor et al., 2023; Starks et al., 2025; Pástor et al., 2024), whereby investors increase their portfolio weight in cleaner firms and reduce, but do not eliminate, their exposure to emission-intensive (brown) firms. This strategy enables investors to engage with emission-intensive firms while signalling a preference for cleaner firms, thereby preserving much of the portfolio's diversification benefits.

Because P&C insurers rely on investment income to fund their underwriting operations, completely divesting from Brown firms would entail substantial income and diversification losses and is therefore unlikely to be a feasible strategy. A survey-based study by Krueger et al. (2020) also found that divestment is among the least preferred strategies adopted by institutional investors to address climate risk exposure in portfolio firms. Moreover, because debt investors do not get voting rights, their means of

[7]See https://www.artemis.bm/dashboard/catastrophe-bonds-ils-issued-and-outstanding-by-year/[Accessed on July 30th, 2025]

engagement with bond-issuing firms are rather limited. One of the approaches that P&C insurers can adopt is to adopt a tilting strategy and invest less in corporate bonds of Brown firms. However, it remains unclear whether such a tilting strategy is driven by 'Value' and 'Values' factors or by the intention to reduce long-run underwriting exposure to physical climate risk.

To understand the actual motivation, we divide P&C insurers into those that are exposed to property losses and those that are not exposed to property losses. If a class of investors displays a different preference for investing in Brown firms' securities, it will reveal the inherent motivation for such investment behavior (Starks et al., 2025). So if the insurers exposed to property losses invest less in corporate bonds of Brown firms, it would indicate that Exposed P&C insurers are trying to reduce long-run risk by tilting away from Brown firms to incentivize the green transition and reduce GHG emissions.

As per NAIC (2025), total outstanding investment in corporate bonds by insurers stands $ 2.98 trillion in 2024. Although Life insurers make the majority of investment in corporate bonds, total outstanding investment of P&C insurers stands around $ 567.63 billion, which comes around 19.05% of total outstanding held by the Insurance industry. Since the total corporate bond outstanding at the end of fiscal year 2024 was around $ 11.2 trillion, the share of P&C insurers comes to around 5.5% of the total corporate bond outstanding in the USA[8]. Therefore, P&C insurers are among the major institutional investors in the corporate bond market, providing low-duration capital.

Since institutional investors are the primary investors in the corporate bond market (Duan et al., 2025), a reduction in investment by major institutional investors such as P&C insurers will put upward pressure on bond yields and force Brown firms to increase their decarbonization efforts. Therefore, if Exposed P&C insurers significantly differ from Other P&C insurers in their investment approaches towards emission-intensive firms, this will reveal that the source of their preference is fundamentally different from transition risk or non-pecuniary preferences, as has been extensively suggested in the literature.

For Exposed P&C insurers, reducing GHG emissions is not about addressing the negative externality and attenuating the adverse impact of climate change on society. Rather, they have a selfish motive: reducing their long-term underwriting exposure to extreme weather events. When it comes to investors' climate risk exposure, one strand of literature has argued that idiosyncratic factors and personal experiences of extreme weather events also matter in shaping narratives around investment adjustments (Alok

[8]See https://www.sifma.org/wp-content/uploads/2024/12/SIFMA-Research-Quarterly-Fixed-Income-O-4Q24.pdf

et al., 2020; Alekseev et al., 2022; Choi et al., 2020) and engagements (Di Giuli et al., 2025). Starks et al. (2025) found that institutional investors with a long-run horizon tend to tilt their equity portfolio towards firms with a better ESG profile. However, this literature does not specifically talk about the adverse financial impact of climate risk on the business operations (source of cash flow for investment purposes) of investors themselves as a factor, as is the case with P&C insurers exposed to property loss exposure.

Since many of the P&C insurers have been in operation since the early 1900s, long-run survival is critical for these firms. If the P&C insurers are worried about the long-run risk exposure to property losses, we should see these firms tilting away from corporate bonds of the Brown firms with the rise in property risk exposure across all the states. Due to the financial materiality of climate risk exposure on the underwriting business, Exposed P&C insurers should behave like a consequentialist investor with the focus on the impact materiality of firms in which they invest. Therefore, we hypothesize:

Hypothesis 1. *With the increase in the risk exposure to property losses, Exposed P&C insurers hold a lower investment in bonds issued by Brown firms.*

Apart from portfolio adjustments in Brown firms, the literature on climate finance also discusses the cost of capital channel. This literature argues that the expected returns from Brown firms differ from those of green firms. Some study shows that investors demand higher returns from Brown firms due to exposure to transition risk (Bolton and Kacperczyk, 2021c,b; Eskildsen et al., 2024; Hsu et al., 2023; Baker et al., 2022). The literature identified two reasons for this phenomenon. First, green firms hedge against climate risk. Therefore, the assets of green firms should be priced higher, and consequently, the expected returns from green firms should be lower than those from Brown firms. Second, some investors are willing to forego part of their return to support green firms due to their non-pecuniary preferences ('Values' motivation).

While another strand of literature argues that when concern for climate change is high, assets of green firms tend to deliver higher returns than Brown firms (Pástor et al., 2021; Ardia et al., 2022; Zhang, 2025; Karolyi et al., 2023). The main driver of green firms' asset outperformance is the demand effect. The demand effect states that as concern about climate change increases, demand for green firms' assets rises, leading to price appreciation and higher expected returns for existing investors. Therefore, the existing evidence on the cost of capital channel is rather mixed.

By studying the investment behavior of P&C insurers, we argue that exposure to transition risk is not the only source of demand for higher returns from Brown firms. Valuation losses due to transition risk are relevant to all investors, regardless of exposure to property losses. However, if Exposed P&C insurers demand higher returns from the

corporate bonds issued by Brown firms, it would indicate that climate risk is endogenous to P&C insurers' operations. These firms demand higher returns on corporate bonds issued by Brown firms to penalize these firms for increasing long-run underwriting risk by emitting GHGs. As a result, the cost of capital increases, and Brown firms are compelled to allocate more capital to reduce greenhouse gas emissions. Pedersen (2026) also argues that in the absence of carbon taxes, the cost of capital is another channel to push emission-intensive firms towards reducing GHG emissions. Therefore, we hypothesize:

Hypothesis 2. *Exposed P&C insurers demand higher returns on corporate bonds issued by Brown firms.*

3. Data

3.1. P&C insurers data

We collect the data related to P&C insurers from the S&P Capital IQ Pro platform for the period 2008-2023. This platform maintains a database related to statutory information filed by insurers with the National Association of Insurance Commissioners (NAIC). P&C insurers file detailed information related to their financials, state-wise business operations, and investment holdings with the NAIC. This database also includes detailed information on private (unlisted) insurers; otherwise, information on private firms is usually challenging to get in such detail. Such granularity of information allows researchers to conduct in-depth analyses of state-level and portfolio-level phenomena. In this study, we also divide P&C insurers into insurers exposed to property losses and those not exposed to property losses. If a P&C insurer earns premiums from Homeowner and Commercial MP businesses, we mark these insurers as exposed to property losses ($Exposed = 1$). We exclude P&C insurers supported by states or are residual insurers[9].

3.2. Corporate Bond Data

We download corporate bond holdings of P&C insurers from the S&P Capital IQ Pro database. Schedule 1 of Part D provides bond-wise and stock-wise holdings for each P&C insurer. The database provides year-end holdings and quarterly trading data of corporate bonds by insurers. Schedule 3 of Part D provides year-wise data on the acquisition of corporate bonds for each P&C insurer. Based on the CUSIPs of municipal bonds reported to NAIC, we obtain bond-level characteristics from the LSEG Mergent Fixed Income Securities Database (FISD). We also used the LSEG Workspace Excel add-in to get the industry codes and Green bonds indicators of corporate bonds

[9]Residual insurer in a state is usually called the insurer of last resort, is recognized by the state insurance regulator, and is backed by state legislation.

held by P&C insurers. To identify bond-issuing firms in emission-intensive industries, we use S&P Trucost data from 2002 to 2020. Following Zhang (2025); Aswani et al. (2024), we take the summation of scope 1[10] and scope 2[11] GHG emission intensities[12] to identify emission-intensive industries based on the average emission intensity calculated for each industry for firms covered in the dataset. Section 9.1 explains the process to identify brown industries. We chose the industry-level indicator because We do not have the emission-related information for each bond-issuing firm whose bonds P&C insurers hold. In this study, we refer to bond-issuing firms in emission-intensive industries as Brown firms.

3.3. Climate Disaster Data & Risk exposure of P&C insurers

We collect data on property damage from the SHELDUS database, maintained and updated by Arizona State University in the USA. SHELDUS provides annual estimates of property loss for events and locations, covering all major natural disasters, including extreme weather events, from 1961 onwards. To calculate the total risk exposure of P&C insurers, following Jung et al. (2023), we multiply the Occurrence Exceedance Probability (OEP) for each state with the state share in Homeowners and Commercial MP businesses in the respective state by P&C insurers and use equation 1 to calculate the risk exposure. This is a probabilistic measure based on historical trends in the property losses reported in the SHELDUS dataset. We use a 30-year rolling window to calculate the OEP for the year under consideration, extending back to the year preceding it (Section 9.4).

$$Risk_{i,t} = \sum_{s=1}^{S} \Big(StateShare_{i,s,t} \times OEP_{s,t} \Big) \tag{1}$$

Where,

$$StateShare_{i,s,t} = \frac{PremiumEarned_{i,s,t}}{\sum_{s=1}^{S} PremiumEarned_{i,s,t}} \tag{2}$$

$StateShare_{i,s,t}$ represents the share of Direct Premium Earned from Homeowners and Commercial MP businesses by insurer i from state s in year t of their total premium earned from Homeowners and Commercial MP businesses. $DPE_{i,s,t}$ is the Direct Premium Earned from Homeowners and Commercial MP businesses by insurer i from

[10] GHG emissions caused by direct burning of the fossil fuel are called Scope 1 Emissions (Bolton and Kacperczyk, 2025).

[11] GHG emissions caused by indirect burning of the fossil fuel (such as purchase and consumption of fossil fuel-based electricity, heat or steam) are called Scope 2 Emissions (Bolton and Kacperczyk, 2025).

[12] Emission Intensity is the ratio of GHG emission of a firm and sales of the firm in a year (Zhang, 2025).

state s in year t. S is the total number of states. For analysis purposes and ease of interpretation, we normalized the Risk parameter on the scale of $1 - 10$.

3.4. Control Variables

At the P&C insurer level, we control for the Size (*Log of Net Total Assets*), Revenue (*Log of Direct Premium Written*), Leverage (*Ratio of Total Liability and Net Total Assets*), Affiliated Investment (*Ratio of Affiliated Investment to Net Total Assets*), Net Underwriting Income (*normalized by the lag of Net Total Assets*), Net Income (*normalized by the lag of Net Total Assets*), Retention Ratio (*Ratio of Net Premium Written to Gross Premium Written*) and *Business Share* (share of premium earned from Homeowners MP and Commercial MP businesses). At the corporate bond level, we control for the bond's tenure, size, and credit rating in NAIC format.

3.5. Summary Statistics

Table 1 presents the summary statistics of key variables. Part A of the Table presents of summary statistics of all the P&C insurers that hold corporate bonds during the period of study. Part B of the Table presents a summary of statistics of all the Exposed P&C insurers with a share in Homeowners and Commercial MP more than 1%. Summary statistics show that the mean of net underwriting gain and net income is lower for Exposed P&C insurers than the overall mean in Part A. Similarly, the retention ratio is also lower for Exposed P&C insurers than the overall mean in Part A, indicating a higher tendency to take reinsurance to cover tail risks. Mean investment (Bond Share Holding) by Exposed P&C insurers in a corporate bond is 0.30% against the overall mean of 0.35%. Average investment in Green bonds by Exposed insurers is 0.231%, compared to the overall average of 0.229%. Average holding of Green bonds by Exposed insurers is $10.29 million against the overall average of $8.32 million.

< Insert Table 1 Here >

4. Empirical Strategy and Results

4.1. Impact on Corporate bond portfolio

If the P&C insurers exposed to property losses are worried about the long-run impact of climate disasters, they should have a smaller share of bonds issued by Brown firms. To identify this impact, we use a standard fixed-effect panel regression model to estimate the impact of exposure to property losses on the corporate bond holdings of Brown firms by Exposed P&C insurers. We argue that exposure to transition risk is not the only channel driving the allocation of investment flows between green and Brown firms. Exposure to physical risks by investors themselves may also drive the allocation of investment flows between green and Brown firms. If P&C insurers exposed to property

losses hold a smaller share of corporate bonds issued by Brown firms, it would suggest that these insurers want Brown firms to reduce GHG emissions now so that long-run risk goes down. Following the regression approach adopted by Ge and Weisbach (2021), we use the regression equation 3 to study the impact of risk exposure to property losses on the share of corporate bond holdings of Brown firms.

$$BondShare_{i,b,t} = \alpha + \beta_1 Brown_b \times Risk_{i,t} + \theta X_{i,t-1} + \mu_W e + \delta_t + \phi_{b,t} + \epsilon_{i,b,t} \quad (3)$$

$BondShare_{i,b,t}$ is the ratio of the carrying value of a bond to the value of Net Admitted Bonds for an insurer i at the end of year t. We calculate the $Risk$ variable using equations 1. $Brown_b$ takes the value 1 if the bonds are issued by Brown firms; otherwise 0. $X_{i,t-1}$ is the vector of insurer-level control variables (lagged). To control for insurer-level time-invariant unobserved heterogeneity, we use insurer-level fixed effects. To control for time-variant unobserved heterogeneity, we use the year-level fixed effects. Following Ge and Weisbach (2021), we cluster standard errors at the bond-year level to address the concern around possible correlation among errors of bonds that are held by multiple P&C insurers.

< Insert Table 2 Here >

Table 2 shows the results of the regression equation 3. In columns (1) to (3), the main dependent variable is the ratio of the carrying value of a bond issued by Brown firms to net admitted bonds in percentage. In this Table, we use the main independent variable, Risk, which represents the risk exposure to property losses, calculated using the OEP as per equation 1.

The result in columns (1) to (3) shows that the main coefficient of interest is negative and statistically significant. In column (3), we also apply industry-year fixed effects of the bond-issuing firm. The result in column (3) shows that a 1 percentage point rise in risk exposure (equation 1) to property losses is associated with 0.00256 percentage point lower share in the individual corporate bond issued by Brown firms. In terms of economic significance, the result in column (3) shows that a 1 SD[13] rise in risk exposure to property losses is associated with 0.00719 SD lower share in corporate bonds issued by Brown firms. This translates into approximately $ 47,475 reduction in a bond issued by Brown firms. The result is robust to the size of corporate bonds. Through this analysis, we find empirical evidence in support of Hypothesis 1.

The results in Table 2 also show that some of the coefficients of bond-related control variables are consistent. The coefficient of Log (Offering Amount) is positive and statistically significant, indicating that the larger the bond size, the larger the investment

[13]Standard Deviation

size in the bond. Additionally, with the increase in NAIC ratings (Table 3.A2), P&C insurers tend to reduce their share in corporate bonds, primarily driven by risk weights under the NAIC[14] and concerns about credit risk.

The results in the Table 2 show that risk exposure to property losses is a material factor that impacts the corporate bond holdings of Exposed P&C insurers. Since P&C insurers usually have exposure in multiple states, and corporate firms have operational exposure across multiple geographies, it is highly unlikely that any other correlated factor may drive changes in corporate bond holdings. If corporate bond holding of Brown firms is sensitive to the property loss exposure of P&C insurers, it indicates that, through the portfolio tilting strategy, insurers are signalling Brown firms to reduce GHG emissions so that underwriting risk goes down in the long run.

4.2. Impact on Required Returns of Corporate Bonds

Apart from studying divestment from Brown firms, we also study whether Exposed P&C insurers demand higher returns from corporate bonds issued by Brown firms. This would also suggest that factors beyond exposure to transition risk also drive the pricing of corporate bonds issued by Brown firms. To test this, we use a panel regression model and regress effective interest rates recorded by P&C insurers on the interaction term of the Brown dummy variable and the Exposed dummy variable to study the association between the demand for returns from bonds issued by Brown firms and Exposed P&C insurers (equation 4).

$$EffectiveInterestRate_{i,b,t} = \alpha + \beta_1 Brown_b \times Exposed_i + \theta X_{i,t-1} + \mu_W e + \delta_t + \phi_{b,t} + \epsilon_{i,b,t} \tag{4}$$

$EffectiveInterestRate_{i,b,t}$ is the dependent variable and represents the return that P&C insurer i is expected to earn by holding a bond b. $Brown_b$ take value 1 if the bonds is issued by Brown firms; otherwise 0. $Exposed_i$ takes the value 1 if a P&C insurer has exposure to Homeowners or Commercial MP businesses. $X_{i,t-1}$ is the vector of insurer-level control variables (lagged). To control for insurer-level time-invariant unobserved heterogeneity, we use insurer-level fixed effects. To control for time-variant unobserved heterogeneity, we use the year-level fixed effects. We use bond-year level fixed effects to control for year-on-year changes in bond-specific unobserved factors. Following Ge and Weisbach (2021), we cluster standard errors at the bond-year level to address the concern around possible correlation among errors of bonds that are held by multiple P&C insurers.

< Insert Tables 3 and 4 Here >

[14]Higher NAIC ratings mean higher credit ratings and higher risk weights.

Table 3 shows the results of the regression equation 4. The result in column (1) is for all the bonds held by P&C insurers. The result in column (2) is for the bonds with an NAIC rating of 1. The result in column (3) is for the bonds with NAIC ratings of 1 and 2. The result in column (1) shows that Exposed P&C insurers demand 0.0302 percentage points (3.02 basis points) higher returns from bonds issued by Brown firms. It may so happen that Exposed P&C insurers may hold a higher share of bonds of Brown firms with lower credit ratings, which may influence the outcome as bonds with lower credit ratings carry higher yields. To address this concern, we only consider investment-grade bond holdings as classified in columns (2) and (3) of Table 3.

In column (2), we only consider bonds with NAIC rating of 1 (AAA, AA, A as per Fitch) and in columns (3), we consider with NAIC rating of 1 (AAA, AA, A as per Fitch) and NAIC rating of 2 (BBB as per Fitch). The result in column (2) shows that Exposed P&C insurers demand 0.0333 percentage points (3.33 basis points) higher returns from bonds with the NAIC rating of 1 issued by Brown firms. The result in column (3) shows that Exposed P&C insurers demand 0.0346 percentage points (3.46 basis points) higher returns from bonds with the NAIC rating of 1 and 2 issued by Brown firms.

In Table 4, we remove bond-level fixed effects and control for the NAIC ratings, offering amount, and tenure of corporate bonds. The result in Table 4 indicates that the coefficient of interest is still positive and significant. The result in column (3) shows that Exposed P&C insurers demand 0.0768 percentage points (7.68 basis points) higher returns from bonds issued by Brown firms. We also observe that the coefficient of interest is even higher in this case. Therefore, the result is robust to bond-level factors that primarily drive bond yields.

We argue that if marginal investors demand a higher return from Brown firms, it would generally be due to exposure to transition risk. However, if firms exposed to property losses demand higher returns from corporate bonds issued by Brown firms, this suggests that Exposed P&C insurers consider factors beyond exposure to transition risk while investing in Brown firms. Since GHG emissions remain in the environment for a significant amount of time, penalizing Brown firms by asking for more returns would suggest that Exposed P&C insurance companies are worried about long-run exposure underwriting risk due to extreme weather events. Therefore, we find that P&C insurers exposed to property losses have begun to endogenize long-run exposure to climate risk in their corporate bond portfolios, leading Brown firms to reduce GHG emissions. Overall, the cost of capital channel is in play here by Exposed P&C insurers.

5. Trends in Acquisitions of Corporate Bonds

5.1. Impact Of Business Share in Homeowners and Commercial MP Businesses and Property Loss Risk

To further study the investment in corporate bonds by Exposed P&C insurers with the rise in risk exposure to property losses, we also study the year-on-year investment in corporate bonds of Brown firms based on details of corporate bonds submitted with NAIC in Schedule D Part 3[15]. We argue that if P&C insurers consider long-run exposure to property losses material, we should observe exposed P&C insurers allocating a smaller share of their total investment in corporate bonds to Brown firms while making fresh investments in a given year. We use the panel regression equation 5 to study whether firms with higher exposure to Homeowners and Commercial MP business invest less in bonds issued by Brown firms.

$$BondShare_{i,b,t} = \alpha + \beta_1 Brown_b \times BusinessShare_{i,t} + \theta X_{i,t-1} + \gamma B_b + \mu_W e + \delta_t + \phi_{b,t} + \epsilon_{i,b,t} \tag{5}$$

Next, we use the panel regression equation 6 to examine whether firms with higher risk exposure invest less in bonds issued by Brown firms.

$$BondShare_{i,b,t} = \alpha + \beta_2 Brown_b \times Risk_{i,t} + \theta X_{i,t-1} + \gamma B_b + \mu_W e + \delta_t + \phi_{b,t} + \epsilon_{i,b,t} \tag{6}$$

$BondShare_{i,b,t}$ is the ratio of the actual cost of a bond to the total value of Net Admitted Bonds. $BusinessShare_{i,t}$ is the ratio of Direct Premium Earned from Homeowners MP and Commercial MP business to Total Direct Premium Earned by firm i. $Brown_b$ takes the value 1 if the bonds are issued by Brown firms; otherwise 0. $X_{i,t-1}$ is the vector of insurer-level control variables (lagged). B_b is the vector of bond-level variables. To control for insurer-level time-invariant unobserved heterogeneity, we use insurer-level fixed effects. To control for time-variant unobserved heterogeneity, we use the year-level fixed effects. We also use industry fixed effects to control for unobserved industry-specific factors affecting bond-issuing firms. Following Ge and Weisbach (2021), we cluster standard errors at the bond-year level to address the concern around possible correlation among errors of bonds since multiple P&C insurers may hold a bond.

Column (1) and (2) of Table 5 show the results of the regression equations 5 and 6, respectively. The results in all columns show that the coefficient of interest (β) is negative and statistically significant. The result in column (1) shows that 1 percentage point rise in business exposure to property losses is associated with 0.000228 percentage point lower share in corporate bonds issued by Brown firms. The result in column

[15]Schedule D Part 3 of NAIC gives the yearly acquisition of corporate bonds by insurers.

(2) shows that 1 percentage point risk is associated with 0.00267 percentage point lower share in corporate bonds issued by Brown firms. Since underwriting exposure to property losses is typically categorized by higher probabilities of tail risk events in the long run with the rise in GHG emissions, lesser investments in bonds of Brown firms in response to a rise in business exposure to property losses further confirm earlier findings that Exposed P&C insurers consider the climate risk endogenous to their underwriting operations. That is why Exposed P&C insurers are looking to reduce the GHG emissions by tilting their corporate bond portfolio away from Brown firms.

< Insert Table 5 Here >

5.2. Impact of Risk exposure on Bond Acquisition as a share of Bond Size

At the intensive margin, we also study whether Exposed P&C insurers respond to the rise in risk exposure to property losses (equation 1) and reduce new investment in corporate bonds issued by Brown firms as a share of the offering amount of bonds. This is critical for bond issuers. Adjustment in portfolio weights within the P&C insurers may not have much impact on Brown firms if the composition of bondholders does not change much. But if P&C insurers exposed to property losses have started investing less (as a share of offering amount) in bonds of Brown firms, it would signal to Brown firms that a class of investors has already started pricing in long-run exposure to climate risk. We use the regression equation 7 to estimate the impact of risk exposure on the corporate bond acquisitions.

$$BondSharebyOffering_{i,b,t} = \alpha + \beta Brown_b \times Risk_{i,t} + \theta X_{i,t-1} + \gamma B_b + \mu_W e + \delta_t + \phi_{b,t} + \epsilon_{i,b,t} \tag{7}$$

Where,

$$BondSharebyOffering_{i,b,t} = \frac{ActualCost_{i,b,t}}{OfferingAmount_b} \tag{8}$$

$ActualCost_{i,b,t}$ is the investment in corporate bond b by P&C insurers i in year t. $OfferingAmount_b$ is the size of the bond. We calculate the $Risk_{i,t}$ variable using equations 1. $X_{i,t-1}$ is the vector of insurer-level control variables (lagged). B_b is the vector of bond-level variables. To control for insurer-level time-invariant unobserved heterogeneity, we use insurer-level fixed effects. To control for time-variant unobserved heterogeneity, we use the year-level fixed effects. We also use industry fixed effects to control for unobserved industry-specific factors affecting bond-issuing firms. Following Ge and Weisbach (2021), we cluster standard errors at the bond-year level to address the concern around possible correlation among errors of bonds since multiple P&C insurers may hold a bond.

Table 6 shows the result of the regression equation 7. The results in all columns show that the coefficient of interest (β) is negative and statistically significant. The result in

column (3) shows that 1 unit rise in risk exposure to property losses is associated with 0.00275 percentage point lower share (as a share of the offering amount or the bond size) in corporate bonds issued by Brown firms by Exposed P&C insurers. This result is robust to bond size, as We also control for the log of the bond's offering amount. Therefore, if We place the value of new bond purchases by P&C insurers in a 2×2 matrix, with total value of admitted of P&C insurers as columns and bond size as rows, we show that P&C insurers have started reducing investment in Brown firms as risk exposure to property losses has risen, not just horizontally but also vertically.

These findings suggest that Exposed P&C insurers value impact materiality (like a consequentialist investor). The source of this motivation is not altruistic, but rather their long-run underwriting exposure to extreme weather events.

< Insert Table 6 Here >

6. Preference Towards Green Bonds

6.1. Year End Holdings by Exposed insurers

Since the Green bonds are generally issued to support projects that reduce GHG emissions (Flammer, 2021), it is critical to understand how P&C insurers invest in Green bonds[16]. In line with the main hypothesis, we argue that if the Exposed P&C insurers are worried about the long-run exposure and these firms have started penalizing the corporate bond of Brown firms, we should see the opposite investment behavior in the Green bonds issued to facilitate a reduction in GHG emissions. We should see a preference towards Green bonds by Exposed P&C insurers. To understand the investment holdings in Green Bonds, we study whether Exposed P&C insurers hold a higher share in Green Bonds compared to Other P&C insurers. We use equation 9 to estimate the impact of exposure to property losses on investment in Green bonds.

$$BondShare_{i,b,t} = \alpha + \beta GreenBond_b \times Exposed_{i,t} + \theta X_{i,t-1} + \mu_W e + \delta_t + \phi_{b,t} + \epsilon_{i,b,t} \quad (9)$$

$GreenBond_b$ takes the value 1 if a bond b is categorized as Green Bond. We obtained information on the green characteristics of the bonds by using the CUSIPs of bonds acquired over the year in the LSEG Workspace Excel add-in. $X_{i,t-1}$ is the vector of insurer-level control variables (lagged). Coefficient of interest is β. Table 7 shows the results of the regression equation 9. In columns (1) to (3), the main dependent variable is the ratio of the carrying value of a bond issued by Brown firms to net admitted bonds in percentage. The result in columns (1) to (3) shows that the main coefficient of

[16]In this study, we mark all the shades of Green, Sustainability-related and ESG Bonds as Green Bonds.

interest is positive and statistically significant. In column (3), we also apply industry-year fixed effects of the bond-issuing firm. We cluster standard errors at the bond-year level. The result in column (3) shows that Exposed P&C insurers are associated with 0.0124 percentage point higher share in Green bonds. This result suggests that Exposed P&C insurers are not only sensitive to the investment in Brown firms, but these firms are also looking to reduce future GHG emissions by holding higher investment in Green bonds to support green transition projects.

< Insert Table 7 Here >

6.2. Trends in Share of Green Bond Acquisitions

Next, we examine whether Exposed P&C insurers have begun acquiring a larger share of Green bonds as part of their total bond investment. We use the regression equation 10 to examine the impact of property loss exposure (equation 1) on the share of investment in Green Bonds as a share of net admitted bonds of Exposed P&C insurers. Since the issuance of Green bonds has increased after the Paris Agreement (COP21), we include the interaction terms of risk exposure and post-COP21 in equation 10.

$$GreenBondShare_{i,t} = \alpha + \beta_1 Risk_{i,t} \times COP21_t + \theta X_{i,t-1} + \mu_W e + \delta_t + \epsilon_{i,t} \quad (10)$$

$GreenBondShare_{i,t}$ is the ratio of the total value of Green bonds acquired by insurer i during the year t to net admitted bonds. $COP21_t$ equals 1 if the year is post-Paris Agreement, that is, after 2015, and 0 for the period up to 2015. $X_{i,t-1}$ is the vector of insurer-level control variables.

We next study whether, with a rise in the risk exposure, Exposed P&C insurers invest more in Green bonds. So, if risk exposure to property losses and the flow of investment in Green bonds are positively correlated, it will show that P&C insurers are indeed worried about the long-run underwriting risk. We use the regression equation 11 to understand the impact of property losses exposure (equation 1) on the green bond investment in absolute terms. Since the issuance of Green bonds has increased after the Paris Agreement (COP21), we use the regression equation 11 to examine the impact of risk exposure on green investment post-COP21.

$$LogGreenBonds_{i,t} = \alpha + \beta_2 Risk_{i,t} \times COP21_t + \theta X_{i,t-1} + \mu_W e + \delta_t + \epsilon_{i,t} \quad (11)$$

$LogGreenBonds_{i,t}$ is the log of the amount invested (in \$000s) in Green Bonds by insurer i in year t. $Risk_{i,t}$ is exposure to property losses calculated using equation 1. $COP21_t$ equals 1 if the year is post-Paris Agreement, that is, after 2015, and 0 for the period up to 2015. Coefficient of interest is β_1 and β_2 in regression equations 10 and 11 respectively. Since the dependent variable is in log, we calculate the effect size using

the equation $100 \times (e^{\beta_2} - 1)$ in %. We cluster standard errors at the insurer level to account for autocorrelation in the error terms.

Table 8 shows the result of the regression equation 10 and 11. The results show that the coefficients of interest, β_1 and β_2, are positive and statistically significant. The result in column (1) shows that a 1 unit increase in risk exposure is associated with a 0.0348 percentage-point increase in the share of Green bonds. The result in column (2) shows that, post COP21, 1 unit rise in risk exposure is associated with 0.0213 percentage point higher share in Green bonds. Columns (3) and (4) show the result of regression equations 11. The result in column (3) shows that 1 unit rise in risk exposure is associated with 24.61% ($100 \times (e^{(0.220)} - 1) = 24.61$) more investment flow in Green bonds by Exposed P&C insurers. The result in column (4) shows that, post COP21, 1 unit rise in risk exposure is associated with 11.74% ($100 \times (e^{(0.111)} - 1) = 11.74$) more investment flow in Green bonds by Exposed P&C insurers.

If we read the results of Hypotheses 1 and 2 with the results in Tables 7 and 8, the preference towards Green bonds by Exposed P&C insurers suggests that these insurers consider long-run underwriting risk a material factor and are willing to support activities that reduce GHG emissions. The result shows that investment in Green bonds is sensitive to the property loss exposure of P&C insurers. A reduction of investment in corporate bonds and an increase of investment flow in Green bonds suggest that long-run exposure to climate risk is a material risk factor for P&C insurers. Since the impact and severity of climate change are uncertain, Exposed P&C insurers are actively looking to reduce GHG emissions by altering their investment strategies.

< Insert Table 8 Here >

7. Robustness

7.1. Insurer-Year level Analysis

Result of Hypothesis 1 in Table 2 shows that 1 unit rise in risk exposure to property losses is associated with 0.00256 percentage point lesser share in individual corporate bonds issued by P&C insurers. However, this result does not indicate whether P&C insurers hold a lower investment share in corporate bonds issued by Brown firms overall. Due to data limitations, it is not possible to map each bond held by P&C insurers with Mergent FISD or Refinitiv data to identify the bond-issuing firms as Brown or non-Brown. Therefore, it is difficult to calculate the exact share of total bond holdings in Brown firms. However, to deal with this problem, we conducted two analyses at the Insurer-Year (I-Y) level. In the first analysis, we marked all the unmatched bonds as non-brown, and in the second analysis, we marked all the unmatched bonds as brown and calculated the share of total bond holdings in Brown firms in each case. Accordingly,

we use equation 12 at the I-Y level to understand the impact of the insurer's risk exposure on bond holding by Brown firms.

$$TotalBrownFirmShare_{i,t} = \alpha + \beta Risk_i \times COP21_t + \theta X_{i,t-1} + \mu_W e + \delta_t + \epsilon_{i,t} \quad (12)$$

Table 9 shows the result of this analysis. The results in columns (1) to (4) consider unmatched corporate bonds as bonds issued by Non-Brown firms. While the results in columns (5) to (8) consider unmatched corporate bonds as bonds issued by Brown firms. As per the analysis in column (1) of the Table 9, it is observed that the coefficient of interest is insignificant. However, the result in column (2) shows that, post COP21, a 1 unit rise in risk exposure is associated with 0.121 percentage points less investment in Brown firms. In the column, we restricted my analysis to only Exposed insurers (firms with non-zero Risk). The result in column (4) shows that, post COP21, a 1 unit rise in risk exposure is associated with 0.153 percentage points less investment in Brown firms. After considering unmatched corporate bonds as bonds issued by Brown firm, the results in columns (6) and (8) still hold, although with lower statistical significance in column (6) with a sample of all the insurers. Overall, the result in this analysis suggests that Exposed P&C insurers have started to reduce corporate bond holdings of Brown firms post COP21.

7.2. Analysis with an Alternate Measure of Risk

In the regression equation 3, we used an alternative measure of property loss exposure, the Log of Total Damages Reported in states during the year, instead of the OEP variable. The results in Table 10 show that the coefficient of interest is negative and statistically significant. The result in column (3) of Table 10 shows that 1 unit rise in the Risk (Log of Damages) is associated with 0.00233 percentage lower share in corporate bonds issued by Brown firms. Therefore, the result of Table 10 shows that Hypothesis 1 is robust to the alternate definition of the Risk variable.

7.3. USA Domiciled Corporate Bonds

Since P&C insurers hold bonds issued by foreign countries also, and the benchmark treasury rate is different in every country, we restrict my analysis of equation 4 to bonds with the USA as the country of domicile. In the Section Table 11, we show that the results of Hypothesis 2 still hold for corporate bonds issued by USA-domiciled forms. The results show that Exposed P&C insurers demand 0.0362 percentage points (3.62 basis points) higher returns from corporate bonds issued by Brown firms domiciled in the USA. The result still holds if We restrict my analysis to bonds with NAIC rating 1 and to bonds with NAIC ratings 1 and 2. In the Section Table 12, we show that the results of Hypothesis 2 still hold for USA-domiciled firms if we also control for bond

level variables. The result indicates that P&C insurers with exposure to property losses have started penalizing USA-domiciled Brown firms by demanding more returns.

7.4. Cross Sectional Analysis

In this robustness analysis, we perform a cross-sectional analysis by only considering the year in which a corporate bond was purchased by P&C insurers. We study whether Exposed P&C insurers demand higher returns from corporate bonds issued by Brown firms. In the Section Table 13, we show that the results of hypothesis 2 still hold for the cross-section of corporate bonds held by P&C insurers. The result in column (4) shows that Exposed P&C insurers demand 0.0657 percentage points (6.57 basis points) higher returns from Brown firms. The result is robust to the insurer, year, and industry fixed effects of bond-issuing firms.

8. Summary and Discussion

In this research, we show that underwriting exposure to property losses is a material risk factor for P&C insurers in the long run. As the underwriting risk exposure to property losses rises, Exposed P&C insurers tend to invest less in the corporate bonds of Brown firms. We find that the reduction in investment in bonds is evident within the corporate bond portfolio and as a percentage of Brown firms' bond size. Although Exposed P&C insurers have not completely divested from Brown firms, they have begun to tilt their corporate bond portfolios away from Brown firms. These findings suggest that Exposed P&C insurers have started to price the long-run climate risk exposure on their underwriting side to force Brown firms to reduce GHG emissions.

Apart from the portfolio adjustment channel, we also find evidence in favour of the cost of capital channel. We find that Exposed P&C insurers demand higher returns from corporate bonds of Brown firms. This result is robust if We restrict my analysis to investment-grade corporate bonds or to bonds with a USA country domicile. By demanding higher returns from Brown firms, Exposed P&C insurers are signalling their preference towards cleaner firms so that Brown firms start to reduce GHG emissions. Since green tilt and demand for higher returns from Brown firms are primarily seen for Exposed P&C insurers, it indicates that these insurers are trying to reduce their long-run exposure to underwriting losses by supporting green firms and nudging Brown firms towards reducing GHG emissions.

To further support the hypothesis that Exposed P&C insurers are looking to reduce GHG emissions, we also study the investment in Green Bonds. We find that post Paris Agreement(COP21), Exposed P&C insurers have started to increase the investment flow in Green bonds. Since Green bonds are issued with the main purpose of supporting green transition, higher flow in these bonds by Exposed P&C insurers further supports

my argument that these insurers are looking to reduce GHG emissions to attenuate uncertainties related to long-run underwriting risk.

The findings of this study have significant implications for policymakers seeking to attract capital to finance climate action projects. This study highlights that altruistic motives alone are insufficient to attract capital. Unless and until investors see some skin in the game, the flow of financial resources to climate action projects will not be sufficient. Since climate change impacts the underwriting operations in the long run, P&C insurers exposed to property losses have started to incentivize a reduction in GHG emissions through their investment portfolio. Therefore, many investors do not fund climate action projects because they do not see climate change affecting their cash flows in the long run.

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Table 1: Summary Statistics

Variables	N	Mean	SD	p25	Median	p75
Part A: All the P&C insurers						
Insurer Level Variables						
Net Total Assets ($ billion)	22796	1.02	5.28	0.04	0.12	0.41
Direct Premium Written ($ billion)	22796	0.35	1.30	0.02	0.07	0.26
Net Underwriting Gain (%)	22796	0.17	5.48	-1.52	0.00	2.28
Net Income (%)	22796	2.26	4.60	0.60	2.26	4.24
Leverage (%)	22796	51.04	21.80	38.74	55.82	67.32
Affiliated investment (%)	22796	3.71	8.56	0.00	0.00	2.35
Retention Ratio (%)	22796	51.77	35.48	17.93	56.11	85.17
Carrying Value of Corporate Bonds ($ million)	22796	169.11	752.65	4.67	19.14	72.64
Net Admitted Bonds (%)	22796	59.80	20.73	46.51	62.53	75.63
Corporate Bond Share (%)	22738	35.28	23.38	17.62	31.27	46.47
Brown Firm Bonds/Net Admitted Bond (%)	22738	3.714	4.234	0.713	2.588	5.070
Green Bond Holding ($ million)	4759	8.32	35.63	0.35	1.10	4.33
Green Bonds/Net Admitted Bond (%)	22738	0.229	0.644	0.000	0.000	0.000
Log(1 + Total Value of Green Bond Acquired)	20450	1.21	2.74	0.00	0.00	0.00
Bond Level Variables (Year end Holding)						
Effective Intesrest Rate (%)	2155410	3.85	1.75	2.65	3.59	4.90
Tenure (Years)	2049360	9.67	5.69	6.01	10.01	10.05
Offering Amount ($ billion)	2049875	1.05	0.95	0.50	0.75	1.25
Bond share Holding (%)	2153903	0.35	0.58	0.04	0.15	0.40
Part B: Exposed P&C insurers						
Insurer Level Variables						
Net Total Assets ($ billion)	13310	1.25	4.38	0.06	0.18	0.57
Direct Premium Written ($ billion)	13310	0.45	1.10	0.04	0.13	0.42
Net Underwriting Gain (%)	13310	-0.15	4.76	-1.54	0.00	1.65
Net Income (%)	13310	2.08	4.11	0.60	2.15	3.93
Leverage (%)	13310	51.09	21.52	40.25	56.12	67.05
Affiliated investment (%)	13310	4.39	9.16	0.00	0.00	4.48
Retention Ratio (%)	13310	45.93	33.98	11.69	47.32	78.50
Carrying Value of Corporate Bonds ($ million)	13310	225.03	906.60	6.22	25.62	93.58
Net Admitted Bonds (%)	13310	59.72	20.07	47.31	61.73	74.60
Corporate Bond Share (%)	13301	34.19	22.69	17.03	30.23	45.28
Brown Firm Bonds/Net Admitted Bond (%)	13301	3.706	4.004	0.884	2.685	5.080
Green Bond Holding ($ million)	2959	10.29	37.40	0.49	1.48	5.49
Green Bonds/Net Admitted Bond (%)	13301	0.231	0.630	0.000	0.000	0.000
Risk(1-10 Scale)	13310	2.39	1.84	1.27	1.91	3.04
Log(1 + Total Value of Green Bond Acquired)	11888	1.35	2.92	0.00	0.00	0.00
Bond Level Variables						
Effective Intesrest Rate (%)	1438634	3.95	1.76	2.74	3.68	5.01
Tenure (Years)	1362526	9.74	5.72	6.02	10.01	10.05
Offering Amount ($ billion)	1362883	1.03	0.93	0.50	0.75	1.25
Bond share Holding (%)	1438269	0.30	0.52	0.03	0.12	0.35
Bond Level Variables (Acquisition)						
Bond share Holding (%)(as % of Net Admitted Bonds)	595880	0.247	0.537	0.012	0.055	0.238
Bond share Holding (%)(as % of offering amount of Bond)	595880	0.251	0.460	0.025	0.080	0.249

Notes: *Leverage* is the ratio of the Net Total Liability to Net Total Assets. *Business Share* is the ratio of total Direct Premium Earned from Homeowners and Commercial MP to Total Direct Premium Earned from all the businesses. *Risk Exposure* is as per the Equation 1. *Bond Share* is the ratio of the Carrying Value of a bond to the total value of Net Admitted Bonds held by an insurer.

Table 2: Impact of Property Loss Exposure on Corporate Bonds

VARIABLES	(1)	(2)	(3)
	Carrying Value of a Bond * 100/ Net Admitted Bonds (%)		
Risk (OEP) X Brown	**-0.00199*** **	**-0.00206*** **	**-0.00256*** **
	(0.000601)	**(0.000602)**	**(0.000620)**
Log (Net Total Assets)	-0.246***	-0.246***	-0.245***
	(0.00308)	(0.00308)	(0.00308)
Log (Direct Premium Written)	-0.0334***	-0.0334***	-0.0329***
	(0.00171)	(0.00171)	(0.00171)
Net Underwriting Gain	-0.00162***	-0.00161***	-0.00156***
	(0.000217)	(0.000217)	(0.000217)
Net Income	-0.00160***	-0.00161***	-0.00166***
	(0.000261)	(0.000261)	(0.000261)
Leverage	-0.000823***	-0.000827***	-0.000855***
	(9.40e-05)	(9.39e-05)	(9.39e-05)
Affiliated Investments	6.60e-05	7.13e-05	6.18e-05
	(0.000154)	(0.000154)	(0.000154)
Retention Ratio	-0.000548***	-0.000547***	-0.000542***
	(5.14e-05)	(5.14e-05)	(5.15e-05)
Business Share	-0.000494***	-0.000503***	-0.000503***
	(8.22e-05)	(8.21e-05)	(8.22e-05)
Tenure	-0.00107***	-0.000861***	-0.000883***
	(6.61e-05)	(6.75e-05)	(6.75e-05)
Log (Offering Amount)	0.0145***	0.0141***	0.0136***
	(0.000547)	(0.000574)	(0.000569)
NAIC Rating:			
2	-0.0388***	-0.0349***	-0.0351***
	(0.000849)	(0.000881)	(0.000888)
3	-0.0890***	-0.0845***	-0.0855***
	(0.000971)	(0.00105)	(0.00106)
4	-0.0995***	-0.0946***	-0.0956***
	(0.00102)	(0.00112)	(0.00114)
5	-0.115***	-0.111***	-0.111***
	(0.00238)	(0.00243)	(0.00249)
6	-0.290***	-0.294***	-0.304***
	(0.0102)	(0.0104)	(0.0107)
Constant	4.132***	4.134***	4.127***
	(0.0408)	(0.0408)	(0.0409)
Observations	1,310,567	1,310,207	1,310,157
R-squared	0.629	0.629	0.630
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry-YEAR FE	No	No	Yes

Notes: The dependent variable is the ratio of Corporate Bond Holding of Brown firms normalized by Net Admitted Bonds. The Main independent variable is Risk exposure, calculated using equation 1. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. *Tenure* is the maturity period of a bond in years. *NAIC Rating* is the credit rating as per the NAIC classification, with base as $NAIC = 1$. *Log(Offering Amount)* is the size of the bond. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. In this analysis, I only consider insurers exposed to property losses *(Exposed = 1)*. Standard errors are in parentheses and clustered at the Bond-Year level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 3: Effective Interest Rates

	All Bonds	NAIC = 1	NAIC = 1 & 2
VARIABLES	Effective Intesrest Rate (%)		
Brown X Exposed	0.0302***	0.0333***	0.0346***
	(0.00486)	(0.00659)	(0.00503)
Log (Net Total Assets)	0.107***	0.0942***	0.0945***
	(0.00333)	(0.00424)	(0.00341)
Log (Direct Premium Written)	0.00445***	0.00395**	0.00690***
	(0.00144)	(0.00182)	(0.00148)
Net Underwriting Gain	0.00497***	0.00336***	0.00389***
	(0.000371)	(0.000478)	(0.000383)
Net Income	-0.00291***	-0.000403	-0.00159***
	(0.000423)	(0.000546)	(0.000439)
Leverage	-0.000372***	0.000241*	-0.000197*
	(0.000108)	(0.000135)	(0.000110)
Affiliated Investments	-0.00184***	-0.00102***	-0.00101***
	(0.000211)	(0.000285)	(0.000222)
Retention Ratio	-0.000647***	-0.000411***	-0.000327***
	(6.90e-05)	(9.00e-05)	(7.24e-05)
Constant	2.392***	2.066***	2.241***
	(0.0384)	(0.0472)	(0.0387)
Observations	2,155,410	1,072,351	1,880,785
R-squared	0.792	0.746	0.738
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Bond-Year FE	Yes	Yes	Yes

Notes: The dependent variable is Effective Interest Rate (in %), which is recorded and communicated by P&C insurers in the NAIC filings. *Brown* is 1 if the bond is issued by a Brown firm, and 0 otherwise. *Exposed* is 1 if a P&C insurer has exposure to Homeowners and Commercial MP businesses, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the Bond-Yeal level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 4: Effective Interest Rates - With Bond Level Controls

VARIABLES	(1)	(2)	(3)
	Effective Intesrest Rate (%)		
Brown X Exposed	**0.0743*** **	**0.0744*** **	**0.0768*** **
	(0.00665)	**(0.00675)**	**(0.00655)**
Log (Net Total Assets)	0.174***	0.174***	0.171***
	(0.00469)	(0.00466)	(0.00461)
Log (Direct Premium Written)	0.0144***	0.0148***	0.0154***
	(0.00210)	(0.00208)	(0.00206)
Net Underwriting Gain	0.00376***	0.00394***	0.00378***
	(0.000531)	(0.000527)	(0.000518)
Net Income	-0.00112*	-0.00127**	-0.00123**
	(0.000606)	(0.000601)	(0.000590)
Leverage	-0.00211***	-0.00201***	-0.00203***
	(0.000162)	(0.000161)	(0.000159)
Affiliated Investments	-0.00302***	-0.00313***	-0.00306***
	(0.000306)	(0.000304)	(0.000301)
Retention Ratio	-0.00127***	-0.00122***	-0.00119***
	(9.62e-05)	(9.55e-05)	(9.48e-05)
Tenure	0.0651***	0.0654***	0.0663***
	(0.000594)	(0.000600)	(0.000581)
Log (Offering Amount)	0.00219	-0.00104	-0.000766
	(0.00367)	(0.00378)	(0.00374)
NAIC Rating:			
2	0.457***	0.486***	0.488***
	(0.00635)	(0.00660)	(0.00658)
3	1.858***	1.884***	1.883***
	(0.0144)	(0.0147)	(0.0147)
4	2.836***	2.872***	2.879***
	(0.0162)	(0.0165)	(0.0163)
5	4.016***	4.059***	4.051***
	(0.0368)	(0.0366)	(0.0369)
6	3.205***	3.147***	3.147***
	(0.0935)	(0.0913)	(0.0815)
Constant	0.467***	0.507***	0.519***
	(0.0718)	(0.0734)	(0.0727)
Observations	2,081,578	2,081,049	2,081,010
R-squared	0.488	0.496	0.504
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry-Year FE	No	No	Yes

Notes: The dependent variable is Effective Interest Rate (in %), which is recorded and communicated by P&C insurers in the NAIC filings. *Brown* is 1 if the bond is issued by a Brown Firm, and 0 otherwise. *Exposed* is 1 if a P&C insurer has exposure to Homeowners and Commercial MP businesses, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. *Tenure* is the maturity period of a bond in years. *NAIC Rating* is the credit rating as per the NAIC classification, with base as $NAIC = 1$. *Log(Offering Amount)* is the size of the bond. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the Bond-Year level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 5: Impact on Acquisition of New Corporate Bonds

VARIABLES	(1) Actual Cost of a Corporate Bond * 100 /Net Admitted Bonds (%)	(2)
Business Share X Brown	**-0.000228*** **	
	(8.46e-05)	
Risk(OEP) X Brown		**-0.00267** **
		(0.00115)
Log (Net Total Assets)	-0.241***	-0.242***
	(0.00515)	(0.00515)
Log (Direct Premium Written)	-0.0248***	-0.0175***
	(0.00243)	(0.00252)
Net Underwriting Gain	-0.00174***	-0.00181***
	(0.000364)	(0.000363)
Net Income	0.000199	0.000158
	(0.000398)	(0.000399)
Leverage	-0.00134***	-0.00136***
	(0.000176)	(0.000177)
Affiliated Investments	0.00245***	0.00219***
	(0.000246)	(0.000243)
Retention Ratio	-0.000866***	-0.000919***
	(8.98e-05)	(9.01e-05)
Tenure	-0.00102***	-0.00102***
	(0.000100)	(0.000100)
Log (Offering Amount)	0.0221***	0.0219***
	(0.00106)	(0.00105)
Constant	3.876***	3.891***
	(0.0721)	(0.0718)
Observations	595,880	595,880
R-squared	0.598	0.599
Insurer FE	Yes	Yes
Year FE	Yes	Yes
Industry-YEAR FE	Yes	Yes

Notes: The dependent variable is the Actual investment in a bond (at the time acquistion) as a share of Net Admitted Bonds of P&C insurers. *Brown* is 1 if the bond is issued by a Brown firm, otherwise 0. *Business Share* is the share of Direct Premium Earned from Homeowners and Commercial MP business. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and are clustered at the Insurer Level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 6: Impact of Risk Exposure on Acquisition of New Corporate Bonds

VARIABLES	(1)	(2)	(3)
	Actual Cost of a Corporate Bond * 100 / Offering Amount of the Corporate Bond (%)		
Risk (OEP) X Brown	**-0.00353*** **	**-0.00275*** **	**-0.00275*** **
	(0.000887)	**(0.000896)**	**(0.000867)**
Log (Net Total Assets)	0.0936***	0.0929***	0.0929***
	(0.00307)	(0.00327)	(0.00306)
Log (Direct Premium Written)	0.0139***	0.0148***	0.0148***
	(0.00168)	(0.00169)	(0.00168)
Net Underwriting Gain	0.00225***	0.00221***	0.00221***
	(0.000307)	(0.000309)	(0.000307)
Net Income	-0.00369***	-0.00365***	-0.00365***
	(0.000380)	(0.000381)	(0.000379)
Leverage	-0.000748***	-0.000787***	-0.000787***
	(8.76e-05)	(9.14e-05)	(8.73e-05)
Affiliated Investments	-0.00173***	-0.00172***	-0.00172***
	(0.000182)	(0.000188)	(0.000182)
Retention Ratio	-9.36e-05	-5.97e-05	-5.97e-05
	(6.01e-05)	(6.08e-05)	(5.98e-05)
Tenure	-0.000238*	-0.000181	-0.000181
	(0.000135)	(0.000168)	(0.000135)
Log (Offering Amount)	-0.201***	-0.202***	-0.202***
	(0.00202)	(0.00257)	(0.00200)
Constant	1.534***	1.556***	1.556***
	(0.0455)	(0.0515)	(0.0452)
Observations	596,234	596,212	596,212
R-squared	0.398	0.402	0.402
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	No	No
Industry-YEAR FE	No	Yes	Yes

Notes: The dependent variable is the share of investment in corporate bonds as a share of the offering amount or size of the bond. *Brown* is 1 if the bond is issued by a Brown firm, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses. Standard errors are clustered at the Bond-Year level in columns (1) and (3) and at the Bond Level in column (2). Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 7: Investment in Green Bonds by Exposed Insurers

VARIABLES	(1)	(2)	(3)
	Carrying Value of a Bond * 100/ Net Admitted Bonds (%)		
Exposed X Greenbond	0.0120**	0.0120**	0.0124**
	(0.00561)	(0.00560)	(0.00560)
Log (Net Total Assets)	-0.298***	-0.298***	-0.298***
	(0.00224)	(0.00224)	(0.00224)
Log (Direct Premium Written)	-0.0124***	-0.0126***	-0.0126***
	(0.000943)	(0.000943)	(0.000943)
Net Underwriting Gain	-0.00104***	-0.00110***	-0.00109***
	(0.000179)	(0.000180)	(0.000180)
Net Income	-0.00116***	-0.00112***	-0.00113***
	(0.000204)	(0.000204)	(0.000204)
Leverage	0.000303***	0.000311***	0.000316***
	(6.73e-05)	(6.75e-05)	(6.74e-05)
Affiliated Investments	0.000747***	0.000734***	0.000746***
	(0.000114)	(0.000114)	(0.000114)
Retention Ratio	-0.000471***	-0.000468***	-0.000468***
	(4.05e-05)	(4.05e-05)	(4.05e-05)
Business Share	-0.000523***	-0.000513***	-0.000522***
	(8.48e-05)	(8.49e-05)	(8.48e-05)
Tenure	-0.000782***	-0.00106***	-0.000757***
	(6.27e-05)	(6.11e-05)	(6.27e-05)
Log (Offering Amount)	0.0148***	0.0171***	0.0153***
	(0.000544)	(0.000515)	(0.000551)
NAIC Rating:			
2	-0.0391***	-0.0438***	-0.0389***
	(0.000812)	(0.000776)	(0.000806)
3	-0.0964***	-0.101***	-0.0952***
	(0.00109)	(0.00101)	(0.00108)
4	-0.108***	-0.113***	-0.107***
	(0.00128)	(0.00116)	(0.00126)
5	-0.123***	-0.128***	-0.124***
	(0.00250)	(0.00238)	(0.00243)
6	-0.317***	-0.307***	-0.308***
	(0.00982)	(0.00938)	(0.00952)
Constant	4.403***	4.386***	4.405***
	(0.0286)	(0.0285)	(0.0286)
Observations	2,087,903	2,088,265	2,087,943
R-squared	0.636	0.635	0.636
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry-YEAR FE	No	No	Yes

Notes: The dependent variable is the ratio of bond holding in Green Bond and Net Admitted Bonds. *Greenbond* is equal to 1 if a bond is a Green Bond. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. *Tenure* is the maturity period of a bond in years. *NAIC Rating* is the credit rating as per the NAIC classification, with base as $NAIC = 1$. *Log(Offering Amount)* is the size of the bond. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. In this analysis, I only consider insurers exposed to property losses *(Exposed = 1)*. Standard errors are in parentheses and clustered at the Bond-Year level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 8: Impact of Risk Exposure on share of Green bonds

VARIABLES	(1) Green Bond Acqusition * 100/ Net Admitted Bonds (%)	(2)	(3) Log (1+ Investment in Green Bonds in $000)	(4)
Risk (OEP)	**0.0348****	0.0168	**0.220*****	0.126*
	(0.0155)	(0.0172)	**(0.0656)**	(0.0709)
Risk (OEP) X COP21		**0.0213*****		**0.111****
		(0.00690)		**(0.0465)**
Log (Net Total Assets)	-0.0225	-0.0214	0.226*	0.230*
	(0.0385)	(0.0383)	(0.122)	(0.121)
Log (Direct Premium Written)	-0.0176	-0.0185	-0.102	-0.107
	(0.0145)	(0.0145)	(0.0714)	(0.0715)
Net Underwriting Gain	-0.00621	-0.00564	-0.0219*	-0.0188
	(0.00552)	(0.00543)	(0.0117)	(0.0115)
Net Income	0.00752	0.00732	0.0319**	0.0307**
	(0.00620)	(0.00618)	(0.0131)	(0.0129)
Leverage	0.00342***	0.00333***	0.00635	0.00590
	(0.00113)	(0.00111)	(0.00401)	(0.00399)
Affiliated Investments	-0.000731	-0.000984	-0.0136	-0.0149
	(0.00296)	(0.00296)	(0.0102)	(0.0101)
Retention Ratio	-0.000130	-9.14e-05	0.00692**	0.00714**
	(0.000624)	(0.000624)	(0.00294)	(0.00293)
Constant	0.362	0.377	-1.405	-1.309
	(0.428)	(0.427)	(1.318)	(1.311)
Observations	11,065	11,065	11,076	11,076
R-squared	0.273	0.273	0.496	0.497
Insurer FE	Yes	Yes	Yes	Yes
YEAR FE	Yes	Yes	Yes	Yes

Notes: The dependent variable in columns (1) and (2) is the ratio of investment in Green Bonds in a year to Net Admitted Bonds. The Dependent variable in columns (3) and (4) is the Log of absolute investment made in Green Bonds by P&C insurers. $COP21$ is 1 if the year is after 2015, else 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the Insurer Level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 9: Impact on Property Loss Exposure on Corporate Bonds

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Unmatched Bonds marked as Non-Brown				Unmatched Bonds marked as Brown			
	Holdings in Brown Firms * 100/ Net Admitted Bonds				Holdings in Brown Firms * 100/ Net Admitted Bonds			
			Exposed = 1				Exposed = 1	
Risk	0.0607	0.151***	-0.0121	0.106	0.0731	0.129**	-0.0733	0.0414
	(0.0432)	(0.0496)	(0.0617)	(0.0700)	(0.0485)	(0.0561)	(0.0743)	(0.0845)
Risk X COP21		-0.121***		-0.153***		-0.0758*		-0.149***
		(0.0373)		(0.0483)		(0.0428)		(0.0538)
Log (Net Total Assets)	-0.0979	-0.114	-0.0369	-0.0391	-0.202	-0.212	-0.102	-0.104
	(0.114)	(0.114)	(0.148)	(0.149)	(0.137)	(0.138)	(0.182)	(0.182)
Log (Direct Premium Written)	0.0272	0.0363	0.00189	0.00817	0.0390	0.0447	-0.0630	-0.0568
	(0.0513)	(0.0512)	(0.0792)	(0.0793)	(0.0596)	(0.0594)	(0.0954)	(0.0955)
Net Underwriting Gain	0.00537	0.00546	0.00221	-0.000517	0.00167	0.00173	-0.00599	-0.00864
	(0.00988)	(0.00987)	(0.0145)	(0.0146)	(0.0119)	(0.0119)	(0.0164)	(0.0165)
Net Income	0.00405	0.00324	-0.00415	-0.00363	0.0141	0.0136	0.00217	0.00267
	(0.0106)	(0.0106)	(0.0153)	(0.0154)	(0.0128)	(0.0128)	(0.0179)	(0.0180)
Leverage	0.00813**	0.00838**	0.0108**	0.0114**	0.0146***	0.0148***	0.0163***	0.0169***
	(0.00376)	(0.00376)	(0.00492)	(0.00493)	(0.00430)	(0.00430)	(0.00579)	(0.00579)
Affiliated Investments	0.0176**	0.0184**	0.00539	0.00739	0.0148	0.0153	0.0134	0.0154
	(0.00812)	(0.00808)	(0.0116)	(0.0115)	(0.0115)	(0.0115)	(0.0162)	(0.0162)
Retention Ratio	0.00146	0.00160	0.00162	0.00131	0.00215	0.00224	0.000372	6.25e-05
	(0.00235)	(0.00234)	(0.00350)	(0.00350)	(0.00273)	(0.00273)	(0.00409)	(0.00409)
Constant	3.225***	3.264***	2.834*	2.687	4.597***	4.621***	4.903**	4.761**
	(1.159)	(1.158)	(1.646)	(1.654)	(1.371)	(1.371)	(1.936)	(1.939)
Observations	24,398	24,398	14,077	14,077	24,398	24,398	14,077	14,077
R-squared	0.562	0.562	0.553	0.554	0.552	0.552	0.556	0.557
Insurer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YEAR FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the ratio of Corporate Bond Holding of Brown firms normalized by Net Admitted Bonds. The Main independent variable is Risk exposure, calculated using equation 1. $COP21$ is 1 if the year is after 2015, else 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the Insurer level. Due to year-level fixed effects, the coefficient of COP21 is not calculated. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 10: Impact on Property Loss Exposure (Log of Damages Reported) on Corporate Bonds

VARIABLES	(1)	(2)	(3)
	Carrying Value of a Bond * 100/ Net Admitted Bonds (%)		
Risk (Log Damages) X Brown	-0.00250***	-0.00255***	-0.00233***
	(0.000902)	(0.000902)	(0.000901)
Log (Net Total Assets)	-0.246***	-0.246***	-0.245***
	(0.00308)	(0.00308)	(0.00308)
Log (Direct Premium Written)	-0.0332***	-0.0332***	-0.0327***
	(0.00168)	(0.00168)	(0.00168)
Net Underwriting Gain	-0.00167***	-0.00166***	-0.00161***
	(0.000218)	(0.000217)	(0.000217)
Net Income	-0.00156***	-0.00157***	-0.00162***
	(0.000262)	(0.000261)	(0.000261)
Leverage	-0.000817***	-0.000820***	-0.000847***
	(9.40e-05)	(9.39e-05)	(9.39e-05)
Affiliated Investments	6.50e-05	7.19e-05	6.19e-05
	(0.000154)	(0.000154)	(0.000154)
Retention Ratio	-0.000538***	-0.000536***	-0.000530***
	(5.16e-05)	(5.15e-05)	(5.16e-05)
Business Share	-0.000509***	-0.000519***	-0.000519***
	(8.21e-05)	(8.21e-05)	(8.21e-05)
Tenure	-0.00108***	-0.000862***	-0.000883***
	(6.61e-05)	(6.75e-05)	(6.75e-05)
Log (Offering Amount)	0.0145***	0.0142***	0.0137***
	(0.000547)	(0.000573)	(0.000568)
NAIC Rating:	-0.0389***	-0.0349***	-0.0351***
2	(0.000849)	(0.000881)	(0.000888)
	-0.0890***	-0.0845***	-0.0855***
3	(0.000972)	(0.00105)	(0.00106)
	-0.0997***	-0.0946***	-0.0957***
4	(0.00102)	(0.00112)	(0.00114)
	-0.116***	-0.111***	-0.111***
5	(0.00238)	(0.00243)	(0.00249)
	-0.291***	-0.294***	-0.304***
6	(0.0102)	(0.0104)	(0.0108)
	4.162***	4.164***	4.158***
Constant	(0.0410)	(0.0411)	(0.0411)
Observations	1,310,567	1,310,027	1,309,978
R-squared	0.629	0.629	0.630
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry-YEAR FE	No	No	Yes

Notes: The Dependent Variable is the ratio of Corporate bond holding of Brown firms normalized by Net Admitted Bonds. The Main independent variable is Risk exposure, calculated using equation 1. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. *Tenure* is the maturity period of a bond in years. *NAIC Rating* is the credit rating as per the NAIC classification with base as $NAIC = 1$. *Log(Offering Amount)* is the size of the bond. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. In this analysis, I only consider firms that are exposed to property losses *(Exposed = 1)*. Standard errors are in parentheses and clustered at the Bond-Year level.. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 11: Effective Interest Rates - Robustness (Bond with USA domicile only)

	(1)	(2)	(3)
	All Bonds	NAIC = 1	NAIC = 1 & 2
VARIABLES	Effective Interest Rate (%)		
Brown X Exposed	**0.0322*** **	**0.0344*** **	**0.0362*** **
	(0.00512)	**(0.00688)**	**(0.00529)**
Log (Net Total Assets)	0.113***	0.0941***	0.0993***
	(0.00370)	(0.00476)	(0.00379)
Log (Direct Premium Written)	0.00515***	0.00594***	0.00806***
	(0.00159)	(0.00203)	(0.00164)
Net Underwriting Gain	0.00502***	0.00328***	0.00377***
	(0.000410)	(0.000533)	(0.000424)
Net Income	-0.00282***	-0.000118	-0.00135***
	(0.000469)	(0.000614)	(0.000488)
Leverage	-0.000461***	0.000109	-0.000295**
	(0.000119)	(0.000150)	(0.000121)
Affiliated Investments	-0.00207***	-0.00133***	-0.00121***
	(0.000237)	(0.000328)	(0.000253)
Retention Ratio	-0.000637***	-0.000295***	-0.000254***
	(7.59e-05)	(0.000101)	(7.98e-05)
Constant	2.319***	2.072***	2.173***
	(0.0422)	(0.0522)	(0.0425)
Observations	1,777,285	862,267	1,545,830
R-squared	0.782	0.730	0.723
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Bond-Year FE	Yes	Yes	Yes

Notes: The dependent variable is the Effective Interest Rate (in %), which is recorded and communicated by P&C insurance firms in the NAIC filings. *Brown* is 1 if the bond is issued by a Brown firm, and 0 otherwise. *Exposed* is 1 if a P&C insurer has exposure to Homeowners and Commercial MP businesses, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the Bond-Year level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 12: Effective Interest Rates - Robustness (Bond with USA domicile only with bond level controls)

VARIABLES	(1)	(2)	(3)
	Effective Intesrest Rate (%)		
Brown X Exposed	**0.0598*** **	**0.0604*** **	**0.0622*** **
	(0.00682)	**(0.00682)**	**(0.00670)**
Log (Net Total Assets)	0.172***	0.174***	0.172***
	(0.00505)	(0.00500)	(0.00494)
Log (Direct Premium Written)	0.0173***	0.0172***	0.0175***
	(0.00226)	(0.00223)	(0.00221)
Net Underwriting Gain	0.00386***	0.00403***	0.00389***
	(0.000570)	(0.000565)	(0.000555)
Net Income	-0.00116*	-0.00130**	-0.00129**
	(0.000654)	(0.000647)	(0.000635)
Leverage	-0.00209***	-0.00199***	-0.00202***
	(0.000173)	(0.000171)	(0.000169)
Affiliated Investments	-0.00264***	-0.00282***	-0.00275***
	(0.000333)	(0.000331)	(0.000329)
Retention Ratio	-0.00115***	-0.00111***	-0.00110***
	(0.000103)	(0.000102)	(0.000101)
Tenure	0.0635***	0.0640***	0.0647***
	(0.000629)	(0.000629)	(0.000611)
Log (Offering Amount)	-0.00196	-0.00213	-0.00143
	(0.00400)	(0.00413)	(0.00408)
NAIC Rating:			
2	0.443***	0.470***	0.473***
	(0.00688)	(0.00713)	(0.00715)
3	1.822***	1.842***	1.838***
	(0.0159)	(0.0163)	(0.0163)
4	2.769***	2.805***	2.820***
	(0.0175)	(0.0179)	(0.0178)
5	3.953***	3.994***	3.995***
	(0.0406)	(0.0402)	(0.0405)
6	3.051***	2.975***	2.987***
	(0.100)	(0.0978)	(0.0876)
Constant	0.518***	0.513***	0.525***
	(0.0775)	(0.0801)	(0.0792)
Observations	1,802,043	1,801,696	1,801,682
R-squared	0.486	0.496	0.504
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry-Year FE	No	No	Yes

Notes: The Dependent variable is the Effective Interest Rate (in %), which is recorded and communicated by P&C insurance firms in the NAIC filings. *Brown* is 1 if the bond is issued by a Brown firm, and 0 otherwise. *Exposed* is 1 if a P&C insurer has exposure to Homeowners MP and Commercial MP businesses, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. *Tenure* is the maturity period of a bond in years. *NAIC Rating* is the credit rating as per the NAIC classification with base as $NAIC = 1$. *Log(Offering Amount)* is the size of the bond. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the Bond-Year level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 13: Effective Interest Rates - Cross Section

VARIABLES	(1)	(2)	(3)	(4)
	Effective Intesrest Rate (%)			
Brown X Exposed	**0.0831*** **	**0.0779*** **	**0.0687*** **	**0.0657*** **
	(0.0215)	**(0.0212)**	**(0.0187)**	**(0.0183)**
Log (Net Total Assets)	-0.266***	-0.257***	0.157***	0.157***
	(0.0580)	(0.0574)	(0.0423)	(0.0420)
Log (Direct Premium Written)	0.0786***	0.0775***	0.0316	0.0316
	(0.0273)	(0.0269)	(0.0208)	(0.0208)
Net Underwriting Gain	0.0296***	0.0297***	0.00483	0.00506
	(0.00709)	(0.00703)	(0.00407)	(0.00405)
Net Income	-0.0330***	-0.0331***	-0.00278	-0.00294
	(0.00741)	(0.00735)	(0.00442)	(0.00439)
Leverage	0.0139***	0.0138***	-0.00253*	-0.00238*
	(0.00209)	(0.00207)	(0.00144)	(0.00141)
Affiliated Investments	-0.00588	-0.00606	-0.00428	-0.00432
	(0.00643)	(0.00632)	(0.00371)	(0.00365)
Retention Ratio	0.00221	0.00220	-0.00146	-0.00139
	(0.00179)	(0.00176)	(0.000983)	(0.000967)
Tenure	0.0569***	0.0572***	0.0543***	0.0548***
	(0.00158)	(0.00158)	(0.00152)	(0.00153)
Log (Offering Amount)	-0.0531***	-0.0605***	0.00627	0.00134
	(0.00813)	(0.00857)	(0.00672)	(0.00693)
NAIC Rating:				
2	0.370***	0.405***	0.485***	0.516***
	(0.0148)	(0.0152)	(0.0128)	(0.0129)
3	1.815***	1.836***	1.961***	1.983***
	(0.0648)	(0.0630)	(0.0610)	(0.0589)
4	2.853***	2.877***	2.958***	2.986***
	(0.0746)	(0.0726)	(0.0673)	(0.0653)
5	4.118***	4.155***	4.121***	4.161***
	(0.113)	(0.109)	(0.107)	(0.104)
6	3.633***	3.586***	3.072***	3.057***
	(0.290)	(0.280)	(0.254)	(0.246)
Constant	5.549***	5.574***	0.498	0.577
	(0.649)	(0.645)	(0.495)	(0.491)
Observations	669,778	669,535	669,778	669,535
R-squared	0.389	0.400	0.514	0.524
Insurer FE	YES	YES	YES	YES
Industry FE	No	Yes	No	Yes
YEAR FE	No	No	Yes	Yes

Notes: The dependent variable is Effective Interest Rate (in %), which is recorded and communicated by P&C insurers in the NAIC filings. *Brown* is 1 if the bond is issued by a Brown firm, and 0 otherwise. *Exposed* is 1 if a P&C insurer has exposure to Homeowners and Commercial MP businesses, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. *Tenure* is the maturity period of a bond in years. *NAIC Rating* is the credit rating as per the NAIC classification with base as $NAIC = 1$. *Log(Offering Amount)* is the size of the bond. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and clustered at the insurer level. Asterisks represent the significance level (*** for the 1% level, ** for the 5% level, and * for the 10% level).

Table 3.A1: Variable Definitions

Variables	Description	Data Source
P&C insurer level variables		
Log (Direct Premium Written)	Log of Direct Premium Written	S&P Capital IQ Pro
Log (Net Total Assets)	Log of Net Total Assets	S&P Capital IQ Pro
Leverage	Ratio of Total Liability and Net Total Assets	S&P Capital IQ Pro
State Share	Ratio of summation of Direct Premium Earned from Homeowners MP and Commercial MP business in a state by an insurer to Total premium earned from Homeowners MP and Commercial MP in all the states (%)	S&P Capital IQ Pro
BusinessShare	Ratio of summation of Direct Premium Earned from Homeowners MP and Commercial MP business to Total Direct Premium Earned from all the businesses for a P&C insurer	S&P Capital IQ Pro
Exposed	Equals 1 if a P&C insurer earns from Homeowners MP or Commercial MP or both in a year; otherwise 0	S&P Capital IQ Pro
Affiliated Investment	Ratio of Affiliated Investment to Net Total Assets	S&P Capital IQ Pro
Retention Ratio	Ratio of Net Premium Written to Gross Premium Written (%)	S&P Capital IQ Pro
Net Underwriting Gains	Ratio of Net Underwriting Gains (Operating Income) to the lag Net Total Assets (%)	S&P Capital IQ Pro
Net Income	Ratio of Net Income to the lag Net Total Assets (%)	S&P Capital IQ Pro
CBShare	Carrying Value of a Corporate Bond held by P&C insurers normalised by Net Admitted Bonds (%)	S&P Capital IQ Pro
GreenBondShare	Ratio of investment in Green bonds during the year and Net Admitted Bonds (%)	S&P Capital IQ Pro
LogGreenBonds	Log (1+ Investment in Green Bonds by an insurer)	S&P Capital IQ Pro
EffectiveInterestRates	Returns on corporate bonds recorded by P&C insurers (%)	S&P Capital IQ Pro
Brown	1 if a bond issuing firm belongs to Brown industry (Table 3.A5); otherwise 0	S&P Trucost
OEP	Occurrence Exceedance Probability is calculated using Event Loss Data. It represents the probability of hitting at least one event with losses more than $ 1 billion in a year	SHELDUS
Risk	Risk of Property losses at the insurer level calculated using equation 1	SHELDUS & Own Calculations
COP21	Equals 1 if the year is after 2015; otherwise 0	

Continued on next page

Variables	Description	Data Source
Bond level variables		
Log (Offering amount)	Log of Offering amount of the bond at the time of issuance	Mergent FISD
Tenure	Tenure of bond in years	Mergent FISD
NAIC	NAIC rating of the bonds as recorded in NAIC filings of insurers	S&P Capital IQ Pro
GreenBond	1 if a bond is marked as Green Bond or ESG Bond; otherwise 0	LSEG Workspace

Table 3.A2: Mapping of NAIC ratings with Credit Ratings given by Fitch

NAIC Ratings	**Credit Ratings Fitch**	**Grade**
NAIC 1	AAA, AA, A	Investment Grade
NAIC 2	BBB	Investment Grade
NAIC 3	BB	High Yield/Speculative Grade
NAIC 4	B	High Yield/Speculative Grade
NAIC 5	CCC	High Yield/Speculative Grade
NAIC 6	CC or Below	High Yield/Speculative Grade

Notes: This table is adopted from becker2015reaching. As per the norms, the National Association of Insurance Commissioners (NAIC) asks insurers to report credit ratings of bonds as per categorization in the above tables. Fitch ratings also represent equivalent ratings from S&P and Moody's.

Table 3.A3: Impact on investment in Green bonds post COP21

VARIABLES	(1) Log (1+ Investment in Green Bonds in $000)	(2)
Exposed	-0.191*	-0.191
	(0.111)	(0.150)
Exposed X COP21	0.447***	0.447***
	(0.0614)	(0.112)
Log (Net Total Assets)	0.299***	0.299***
	(0.0549)	(0.0754)
Log (Direct Premium Written)	-0.0158	-0.0158
	(0.0269)	(0.0380)
Net Underwriting Gain	-0.00603	-0.00603
	(0.00654)	(0.00747)
Net Income	0.0124	0.0124
	(0.00766)	(0.00806)
Leverage	0.00270	0.00270
	(0.00174)	(0.00251)
Affiliated Investments	-0.0114**	-0.0114
	(0.00452)	(0.00717)
Retention Ratio	0.00479***	0.00479***
	(0.00126)	(0.00172)
Constant	-2.575***	-2.575***
	(0.541)	(0.763)
Observations	20,450	20,450
R-squared	0.467	0.467
Insurer FE	Yes	Yes
YEAR FE	Yes	Yes

Notes: The Dependent variable is the Log of investment done in Green Bonds in a year (in $000) by an insurer during the year. *COP*21 is 1 if year is after 2015, else 0. *Exposed* is 1 if a P&C insurance has exposure to Homeowners MP and Commercial MP businesses, otherwise 0. *Leverage* and *Affiliated Investments* are normalized by *Net Total Assets*. *Net Underwriting Gains*, and *Net Income* are normalized by the lag of *Net Total Assets*. All the insurer-level variables are lagged by one year and are winsorized at 1^{st} and 99^{th} percentile levels. Standard errors are in parentheses and are clustered at the insurer level. Significance levels are represented by asterisks, *** for the 1% level, ** for the 5% level, and * for the 10% level.

9. Data Processing and Sample Construction

9.1. Processing Corporate Bond Holdings

1. We use the Insurance Investment Holdings datasets from the S&P Capital IQ platform to download year-end corporate bond holdings of P&C insurers.
2. To select corporate bonds held by P&C insurers, we use the following screening criteria on S&P Capital IQ Pro:
   Issuer Type (As Reported) [20XX Y] ="Industrial" and **Issuer Type Description** = "Corporate Issuer" and **Asset Issuer Type** = "Industrial" and **Asset Type (As Reported) [20XX Y]** = "Long-term Bond, Issuer Obligations"
3. To select corporate bonds acquired by P&C insurers during the 2008-2023, we use the following screening criteria on S&P Capital IQ Pro:
   Issuer Type (As Reported)(2024) ="Industrial" and **Asset Issuer Type** = "Industrial" and **Asset Type** = {"Long-term Bond, Issuer Obligations", "Long-term Bond"}
4. To get the bond level information, we merge the bond holding data with the LSEG (Mergent) FISD. We use the SIC code provided in the FISD to identify the industry of bond-issuing firms. However, not all corporate bonds match the Mergent FISD database.
5. To identify the SIC code bonds, we also get the information from the LSEG Workspace Excel add-in using the CUSIP of corporate bonds.
6. In some bonds, the SIC code of bond issuing firms is not the same in the FISD and LSEG Workspace. We consider SIC codes obtained from the LSEG workspace.

9.2. Identifying Brown Firms

1. We use S&P Trucost Environmental dataset to identify Brown firms for the period 2002-2021. Using the 'gvkey' of firms reported in the Trucost database, we obtain industry-level information (NAICS codes, 4-digit SIC codes) from Compustat and Compustat Global for US and global firms, respectively, via the WRDS platform. We use the sum of Scope 1 and Scope 2 emission intensity variables to identify firms in brown industries based on the 2-digit SIC classification.
2. For each industry, we calculate the average of the Scope 1 and Scope 2 emission intensity summation. We mark all firms in an industry with a total emission intensity above the 90th percentile of all industries' average emission intensity (716.14 tCO2e/$M) as 'Brown'. We use SIC 2-digit codes to merge with the individual bond data to identify bonds issued by Brown firms.
3. Table 3.A5 shows the full SIC code-wise list of brown and non-Brown firms. Accordingly, we mark all corporate bond-issuing firms with SIC 2-digit codes 1, 10, 12, 32, 33, 44, 45, and 49 as brown.

4. Since the 49 SIC 2-digit represents all the power-generating utilities, we do not mark firms with NAICS codes (“221111", “221113", “221114", “221115", “221116") that represent non-fossil fuel-based power-generating utilities as brown.

Table 3.A5: Industry-wise GHG emission intensities

SIC	GHG Intensity Scope 1 and Scope 2 (tCO2e/$M)					90th percentile	**Brown**
	N	Mean	Min	Max	p50		
32	**2056**	**3472.87**	**3.01**	**27756.61**	**1202.78**	**716.14**	**1**
49	**5093**	**3087.50**	**0.64**	**425599.31**	**751.87**		**1**
12	**697**	**2596.39**	**7.26**	**48840.55**	**2681.69**		**1**
33	**3187**	**1215.61**	**3.18**	**43561.35**	**301.66**		**1**
1	**324**	**1193.12**	**10.25**	**13036.52**	**1014.51**		**1**
44	**1337**	**1053.49**	**3.94**	**14418.96**	**1098.79**		**1**
45	**1092**	**887.51**	**11.85**	**7806.40**	**1017.60**		**1**
10	**2050**	**718.09**	**0.02**	**35377.95**	**424.60**		**1**
2	80	698.57	23.23	2752.37	461.61		0
46	45	689.39	44.10	5123.76	164.37		0
26	1129	669.48	2.43	82413.02	519.45		0
13	2574	494.01	0.38	10566.99	332.41		0
14	208	489.07	8.17	3719.67	354.91		0
29	1143	433.79	7.58	6349.65	320.28		0
22	649	359.87	0.21	13512.77	233.40		0
40	278	312.12	2.55	978.14	279.16		0
28	10846	307.50	0.37	207408.91	46.36		0
99	1214	306.24	0.12	8550.48	97.64		0
7	67	274.43	10.60	3121.72	48.50		0
16	1444	250.10	2.01	61518.97	39.15		0
30	1266	215.38	2.28	16307.41	128.91		0
24	405	205.76	13.61	6670.06	167.03		0
70	544	188.27	17.57	3010.70	107.42		0
42	557	186.28	2.06	1132.83	143.36		0
9	54	185.30	11.73	568.65	96.90		0
20	4757	176.49	2.04	14537.72	84.99		0
34	1398	166.46	0.82	4437.60	63.13		0
41	240	158.31	1.52	664.22	148.90		0
47	1089	144.51	1.11	2743.52	46.46		0
36	8128	119.03	0.67	127494.23	68.02		0
50	2123	112.98	0.09	7013.78	40.27		0
87	1416	99.15	1.37	9828.12	21.72		0
51	1305	97.03	0.46	9695.22	40.22		0
65	4549	95.41	0.10	5439.85	68.14		0
67	4900	93.45	0.00	2160.59	70.98		0
58	1112	93.19	3.14	1409.29	89.55		0
79	949	93.11	0.71	2486.22	57.56		0
23	974	88.99	0.02	3107.97	52.81		0
37	3815	86.96	1.75	21000.68	35.75		0
8	5	86.01	35.92	174.10	39.27		0
55	638	85.85	0.02	2626.39	70.09		0
15	1330	82.16	0.63	43271.52	36.36		0
31	267	80.45	5.46	812.02	81.64		0
53	1234	74.20	2.59	6765.82	54.27		0

Table 3.A5 continued from previous page

52	274	68.40	15.43	381.66	51.97	0
72	208	65.27	7.36	1006.01	61.76	0
82	557	65.24	8.80	285.27	30.49	0
35	6079	64.48	1.27	12445.35	38.16	0
57	427	60.38	2.06	312.69	60.20	0
75	201	58.44	0.36	917.84	21.06	0
78	428	57.05	0.78	2871.57	19.82	0
83	44	56.27	31.43	70.79	61.02	0
54	865	55.03	1.87	277.39	53.53	0
21	290	52.30	6.41	598.03	23.88	0
80	1041	51.90	0.67	1026.65	45.97	0
56	727	49.52	2.18	153.54	53.48	0
38	3375	48.89	2.33	905.37	35.80	0
59	1404	48.49	0.28	1288.78	50.56	0
25	352	45.01	14.53	163.92	38.72	0
39	770	42.28	2.37	647.56	31.84	0
27	701	39.89	0.52	402.35	23.05	0
17	440	34.50	0.74	672.21	33.82	0
48	3284	31.19	0.24	1022.35	17.62	0
89	48	29.21	11.45	83.21	20.49	0
76	7	28.58	13.27	50.29	15.05	0
73	8532	26.46	0.24	15799.54	14.05	0
62	2798	25.53	0.14	13473.01	7.96	0
61	1260	12.23	0.49	369.39	9.01	0
81	28	11.01	2.45	14.53	12.88	0
64	190	11.00	2.33	112.12	8.62	0
60	7430	7.62	0.01	2523.09	2.81	0
63	2813	4.41	0.02	1244.74	2.60	0

9.3. Identifying Exposed insurers

1. As a first screening criterion, we drop P&C insurers financially supported by states or affiliated with states. These insurers cater to residual P&C business and usually act as insurers of last resort in a state.
2. We keep all the insurers that have earned more than $ 100,000 direct premium (DPE) in at least 5 years or have positive DPE for at least 5 years or more during the study period (2008-2023)
3. We drop all the observations for which the year under consideration is equal or before the year of establishment of insurers, and total DPE is earned for all such years. This indicates that insurers might not have existed for all such years.
4. Since We want insurers that have been in operation for a sufficient period of time during the study period, we drop all the insurers with a positive DPE of less than five years and a DPE of more than $ 100,000 for less than five years. Also, we dropped all the insurers that have never earned a premium of more than $100,000 during the study period.
5. Firms should have achieved a Net Total Asset of more than $ 10 million at least once during the study period (2008-2023) (Knox and Sørensen, 2023).
6. Following the study by Jung et al. (2023), we mark insurers that earn a premium Homeowners or Commercial MP businesses from any state as exposed to property losses due to extreme weather events. So, suppose the summation of Direct Premium Earned (DPE) from Homeowners and Commercial MP businesses is greater than zero in a year. In that case, we mark these insurers as exposed to property losses, irrespective of the exposure and business share in the states.
7. After following step 6 above, we find that there were insurers that were not exposed to property losses in any of the years during the period of study, 2008-2023. Then, some insurers incurred property losses each year during the study period. We keep all these insurers for my study. However, some insurers experienced property losses for some years and were not exposed in the rest. If the transition from no exposure to exposure, or vice versa, has occurred only once, we keep these insurers for my study. We mark these insurers as exposed for all years with positive premiums from Homeowners or Commercial MP businesses. Otherwise, we mark them unexposed for all other years. We exclude all insurers with more than one transition to exposure to property losses, as it is very difficult to categorize them by property loss exposure, given that frequent transitions may affect the analysis.

9.4. Calculating Occurrence Exceedance Probability (OEP)

We use hazard-wise property losses reported for states by the SHELDUS database released by Arizona State University[17] to quantify the OEP, which We use as a proxy of the risk of property losses in the states of the USA. We use a 30-year rolling window to calculate the OEP for each year, starting in 2008, for each state, to account for changes in risk over time. Following the derivation of OEP, we perform the following steps to calculate OEP for each state:

1. We obtain the mean and standard deviation of the Log of losses reported for all hazards in each state over the last 30 years, excluding the current year (2008-2023). We exclude losses reported in the current year to address concerns about look-ahead bias, as it takes time to quantify losses from extreme weather events. Since SHELDUS aggregates the impact of multiple events with the same hazard in the state in a year, it is not possible to calculate the OEP based on events. Therefore, we use hazard-based aggregate measures to calculate OEP in this study.
2. To identify the distribution of losses reported in the past, we generated the Q-Q plot of the log of losses reported in the SHELDUS database for the last 30 years. As shown in Chapter 2 of this thesis, losses approximately follow the log-normal distribution, or the log of losses approximately follows a normal distribution. Therefore, for practical purposes, we apply normal distribution on the log of losses to calculate the exceedance probability.
3. Since NOAA considers a loss beyond $ 1 billion a major event, we calculate the exceedance probability of a hazard with losses of more than 1 billion. For this, we first calculate the z-statistics for each state s and year t using the mean and standard deviation of the log losses over the last 30 years, excluding the year under consideration.

$$z_{s,t} = \frac{Log(1000000000) - Mean(LogLosses)}{SD(LogLosses)} \tag{13}$$

4. We calculate the Exceedance Probability (EP), the probability that losses exceed 1 billion. So if $\Phi(.)$ is the c.d.f of Standard Normal Distribution, Exceedance Probability will be:

$$EP_{s,t} = 1 - \Phi(z_{s,t}) \tag{14}$$

5. Next, assuming that the number of hazards with losses reported follows the Poisson distribution, we calculate the parameter λ for each state for each year. So, in a state s, the number of hazards that occurred can be represented as:

$$E_{s,t} = \{e_{t-1}, e_{t-2}, e_{t-3}, ...e_{t-30}\} \tag{15}$$

[17] See https://cemhs.asu.edu/sheldus

Where e_{t-i} represents the number of hazards in i^{th} year before the year t.

6. So, following MLE, the Poisson Parameter will be:

$$\lambda_{s,t} = \frac{\sum_{i=1}^{30} e_{t-i}}{30} \tag{16}$$

7. So the OEP of at least one hazard with more than $ 1 billion loss occurring in a state s year t will be:

$$OEP_{s,t} = 1 - e^{-\lambda_{s,t} EP_{s,t}} \tag{17}$$